Electrical World

The consolidation of ELECTRICAL WORLD and ENGINEER AND AMERICAN ELECTRICIAN.

VOL. LVI. NEW YORK, THURSDAY, OCTOBER 6, 1910. No. 14.

PUBLISHED WEEKLY BY THE

McGraw Publishing Company

239 WEST THIRTY-NINTH STREET, NEW YORK.

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TELEPHONE CALL: 4700 BRYANT. CABLE ADDRESS: ELECTRICAL, NEW YORK.

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A. S. McALLISTER.....Associate Editor
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TERMS OF SUBSCRIPTION.

United States, Cuba and Mexico, $3.00 per year; Canada, $4.50 per year. All Other Countries, $6.00 per year. Foreign subscriptions may be sent to our European office.

Requests for changes of address should be made one week in advance, giving *old* as well as new address. Date on wrapper indicates the month at the end of which subscription expires.

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Entered as second-class matter at the post office at New York, N. Y.

The circulation of Electrical World for 1909 was 945,850. Of this issue 22,000 copies are printed.

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ILLUMINATING ENGINEERING COMVENTION AND LECTURES.

More than ordinary interest centers around the forthcoming convention of the Illuminating Engineering Society in Baltimore, an outline of which is given elsewhere in this issue. Not only are the papers to be presented of thoroughly solid character, but the convention itself represents to a large extent the introductory exercises connected with the beginning of a course of lectures on illuminating engineering under conditions of much more than temporary importance. Following the regular sessions of the convention, an admirable feature of which will be the abundance of time available for discussion, a course of thirty-six lectures will be offered under the joint auspices of the Illuminating Engineering Society and Johns Hopkins University. It is probable that at no time during the history of engineering education have lectures and subjects been selected for a course of instruction with more care than was bestowed upon the Johns Hopkins course in illuminating engineering. The subjects were arranged according to the well-defined needs of those seeking instruction, and each lecturer was chosen solely with reference to his knowledge of the subject and ability to treat a certain branch of illuminating engineering in the most instructive manner.

The inauguration of the Johns Hopkins course of lectures means much to the Illuminating Engineering Society, the good work of which during the past five years has rendered this result possible by first creating an appreciation of the laws of illumination, then generating a demand for greater knowledge of the subject, and finally supplying the means for the acquisition by anyone of the knowledge which has been accumulated by the recognized leaders of the newly created profession of illuminating engineers. Although it is too soon to define the knowledge which an illuminating engineer must possess in order to be considered as such, and doubtless many years will elapse before engineering colleges will confer the degree of I.E. upon their graduates—if perchance such a specialized profession will ever justify the use of a special degree—yet no one can question the importance of the establishment of the Johns Hopkins lecture courses in illuminating engineering, which will serve as a guide for other colleges that do now, or that will hereafter, offer courses in the same subject.

AN UNUSUAL FIELD FOR THE CENTRAL STATION.

Elsewhere in our columns will be found a rather complete account of what strikes one as a most novel and interesting field of activity for the central station—the furnishing of energy to a large ship-repairing and dry-docking plant. Electric motors have been used for a long time in ship-building yards to a minor extent. The present case, however, involves the supply of central-station energy to a very large repair plant with a multiplicity of dry docks, so that energy is demanded both by general machine-shop work and for pumping on a gigantic scale at short notice and at any time of the day or

night. The plant itself is an old and famous one, which grew like many other works in an irregular fashion until the problem of motor service came to be a very grave one. Most of the service at first required was obtained by non-condensing engines supplied with steam from somewhat inefficient and inadequate boiler plants. To change over the entire system for the application of electric motors was no small task, and to so arrange it that it could be economically handled by purchased central-station energy was really a notable feat. Results have proved the entire reliability and usefulness of the change, for in more than one and a half years of operation there has been only one brief interruption to service caused by a short-circuit in the cable. Energy was supplied from the 6600-volt, three-phase, 25-cycle system of the Edison Electric Illuminating Company of Brooklyn, and reduced to suitable motor voltage at scattered substations around the works. The motors are of the induction type, some of them constant-speed and some worked for variable-speed service by the use of resistance in the secondary circuits. Perhaps the most remarkable single application of motors was to the 6000-ton floating dry dock. The use of this equipment at full-capacity service requires the pumping of approximately 10,000 tons of water, which is accomplished by ten 12-in. centrifugal pumps on each side of the dock, each group being operated by a 300-hp electric motor through the medium of line shaft and bevel gears. The pumping machinery on both sides of the dock, which is under complete control by a single man, has proved to be extremely efficient and convenient. The conditions with respect to the amount of energy at times needed and the unusual hours that it might be required in case of rush work were such as to make the installation of an isolated plant for this service inconvenient and expensive, while with central-station connection it is possible to obtain an almost unlimited supply of energy whenever it is really needed. On the other hand, the load is such that it can be kept off the peak at the station under most service conditions. Altogether the installation is a most interesting demonstration both of the enormously useful field of motor-driven apparatus and of the opportunity for central stations not only to enter the ordinary field of motor working, but to meet great and extraordinary requirements on an economical basis.

A STUDY IN MOTOR LOADS.

Mr. W. S. Kelley contributes to the current number an interesting statistical study of motor loads and their peculiarities as derived from examination of data from a number of Massachusetts stations. We can only touch upon some of the points brought out, but the tables will repay careful reading since Mr. Kelley has for a good many years made a study of motor conditions, and the data from Massachusetts, while far from perfect, are on the whole more satisfactory and conclusive than the official data from stations in other States, owing to the long labors of the Massachusetts Gas and Electric Light Commission. Mr. Kelley's investigations cover a large number of cities, omitting the very largest and the smallest, and hence they are typical of ordinary urban conditions rather than of those found in large centers of population or in the country stations. One important table deals with the cost of service as derived from six typical stations. The point of this particular investigation was to ascertain as nearly as possible the relative cost of supplying energy to motors and to lamps. Such a comparison can, of course, deal only with averages, but in so far as averages are justifiable the results are important. The main point is that it is shown that, including all items of cost, general expense and depreciation, a kw-hour of energy for lamps delivered at the meter costs nearly double the kw-hour at the meter for motors. This result is a little surprising, although it is well known that distribution costs of lighting load are high. The discrepancy shown is rather larger than would ordinarily be considered likely. The distribution expense is the point of greatest difference between the two classes of service. The result is a rough justification of the very common situation found in central-station practice of making normal motor rates per kw-hour about one-half those charged for energy used in lighting. We are inclined to think, however, that with a properly-developed motor load, and particularly with a large and scattered motor load, the difference would be less than that found from the stations investigated.

A special point of interest is the examination of the motor load-factor in various industries. While the highest load-factors are found in motors used in textile mills, the textile industry, as a whole, shows a slightly lower load-factor than is, for example, found in shoe factories, while the diversified small industries, generally supposed to tend toward large load-factor, make a somewhat unsatisfactory showing. This result is perhaps due to the general conditions surrounding the small industries rather than to any failure of the usual law of averages. The difference is probably largely or completely made up by the variation of the diversity-factor, so that it remains yet to be proved that a large and varied load of industrial motors is any less advantageous from the standpoint of the man at the station than the load of motors employed in textile works, and it is certain that the diversified load would bring a much larger return than Mr. Kelley's figures actually show. These statistical studies of station conditions are extremely useful in bringing out broad facts which otherwise would either escape notice or be wrongly interpreted. They require, on the other hand, great caution to secure sound conclusions with respect to any particular case, since local factors enter into the final adjudication of such matters to an extent often overwhelming.

THE APPLICATION OF STATIC ELECTRICITY TO THE SEPARATION OF MINERAL PARTICLES

The use of the magnetic field for the continuous separation of magnetic oxides of iron from accompanying non-magnetic mineral materials is well and widely known, but the use of the electric field for the continuous separation of conducting from non-conducting substances is not widely known. A description of an electrostatic separating mill is given in this number by Mr. Henry A. Wentworth. The magnetic field in ore milling is necessarily limited in application to ores of the magnetic metals, iron, nickel, cobalt and manganese, while in practice it is confined to iron, the most powerfully magnetic metal of all. The electric field is capable of much wider range in application because not only do mineral substances differ markedly in their electric conductivities, but these conductivities are also capable of being altered artificially, in the test ore, by various methods of treatment. On the other hand, magnetic fields can readily be applied in an ore-milling machine or process to a very considerable intensity, and without much difficulty, whereas electrostatic fields are difficult to apply, especially with any

considerable intensity. Damp weather is a great enemy to electrical action, whereas it causes no particular detriment to magnetic action.

Considerable ingenuity is required in arranging ore-milling apparatus for the application of an intense electric field. The generating apparatus must be of a very special kind and the insulation of the high-tension electrodes must be carefully maintained. Some of the difficulties that have to be overcome are described in the article. Another advantage possessed by the electric over the magnetic separator lies in the greater possibilities of extension which lie before its application. New ways of treating the ore and new ways of applying or of producing the electric field may confidently be expected, whereas the prospects of introducing marked improvement into the magnetic separator are by no means dazzling. An essential element in all separators, whether electric or magnetic, is the preliminary crushing process, which includes the principal share in the expense of the treatment. In bulk the mineral substance obeys gravitation wholly, but neither electric nor magnetic forces in appreciable degree. As the ore is crushed to smaller and smaller particles, the sway of the electric forces increases, while that of the gravitational force remains theoretically the same. Practically speaking, when the particles are very fine the sway of gravitational force upon them is virtually reduced, because of the frictional resistance of the air to their descent. Whatever extra air resistance exists is a gain to the electric force by giving a longer time for its application. Another advantage of the electric process is that, if it can be applied to any extent, it can probably be applied with increasing effectiveness and economy on a very large scale with comparatively little attendance and supervision.

PHOTOGRAPHIC PHOTOMETRY.

A very interesting paper on some peculiarities of photographic photometry by Mr. Brush is abstracted in the Digest. The research, while far removed as yet from the realm of ordinary photometry, deals with matters which are of considerable theoretical importance and which may not be lacking in practical application. Photometry is at present passing through a somewhat critical phase. In particular, heterochromic photometry, which is likely steadily to assume greater importance, is in an extremely unsatisfactory state and the possibilities of applying photographic methods to this particular class of work have been several times considered. It is perfectly true that the sensitiveness of ordinary photographic plates does not approximate to the luminous values determined by the eye. On the other hand, the eye is so notoriously ineffective in heterochromic photometry, owing to various little-understood physiological and psychological factors, that it is not without the range of possibility that relief may be found in photography. It should not be an impracticable thing to find a combination of sensitizer and screen which will come very near to duplicating the luminosity curve of the normal eye. In such case it would be easy to compare lights of different colors by a method which would not only give their relative luminosity values but would secure a permanent record of them. Mr. Brush's investigation throws much light on the conditions necessary to be fulfilled in the application of such a method. In the first place he finds it practicable by a suitable length of exposure so timed as to give the maximum contrast for minimum difference in illumination to secure prints showing variations of less than 1 per cent in the light to which they were exposed. It seems altogether probable that by suitable means of comparing densities one could obtain photographic determinations comparable in precision to the readings of an ordinary photometer, and certainly much better in precision than heterochromic comparisons have generally proved to be. Moreover, with suitable exposures the operation practically would call for little time or trouble other than that taken in treating the plates after exposure. In the relation between size and density of images the effective luminosity has been pretty carefully worked out in stellar photography so that sufficient data are available. Great caution evidently must be exercised regarding uniform development, and one of the points brought out in the course of Mr. Brush's investigation was the desirability of carrying on the developing process in a tray considerably larger than the plate, the plate being fixed in the middle of the tray with its face flush with the bottom. Moreover, the strength and temperature of the developer must be very carefully adjusted to a normal condition.

Two curious limitations found in the photographic process are worth mentioning. One of them concerns the inertia of the chemical change that produces the exposed plate. Apparently in starting the photographic action there is a certain inertia requiring a definite amount of energy. A certain amount of lack of sensitiveness has to be overcome before any image is formed, and if exposure is stopped near this critical point the plate decreases in sensitiveness instead of increasing as it would if exposure had been continued, so that the inertia must be overcome again on a second exposure. This means, of course, that one must work above certain critical values of illumination and exposure in order to have proportionality of results. A second interesting fact strongly brought out in the research is the continuance of the inertia effect after exposure ceases. It was evident from Mr. Brush's experiments that for some minutes at least the chemical action continues, so that development before the termination of this inertia period does not show the full effect of the exposure. These, however, are not things which need seriously interfere with the usefulness of photography in many photometric problems. They are merely indications of precautions to be taken. The paper is extremely well worth the reading in full by anyone interested in scientific photography as well as by the photometrist.

TEMPERATURE-COEFFICIENTS OF ELECTRICAL RESISTIVITY

The last number of the *Physical Review* contains a paper by Mr. A. A. Somerville on temperature-coefficients of electric resistivity, especially at relatively high temperatures, all with reference to the resistivity at 0 deg. C. as standard. In electric measurements and applications the temperature-coefficient of copper is an important physical constant. Hardly any dynamo-electric machine can be tested without having the temperature-coefficient for the resistivity of its copper windings involved in the process. The earliest systematic measurements of the coefficient for copper were made by Dr. Matthiessen in England about half a century ago. They did not indicate a straight-line law of increase in resistivity with temperature. On the contrary, they indicated an upwardly curving parabolic line, commencing at 0.388 per cent per degree C. at 0

deg. C., and rising above 0.4 per cent per degree C. at 100 deg. C., referred to the same initial value. It is admitted, however, on all sides that the quality of copper obtainable at that time was inferior to that commercially supplied at the present day. In recent years the resistivity of copper has generally been observed to follow substantially a straight-line law with respect to temperature, at least between the limits of 0 deg. C and 100 deg. C. In Mr. Somerville's observations there appears, however, to be a slight downward bend in the curve near room temperatures, the coefficient being given as 0.36 per cent at 25 deg. C., 0.4 per cent at and near 200 deg. C. and 0.6 per cent near 1000 deg. C. In a general way, the results may be described by saying that between 0 deg. C. and 700 deg. C. the coefficient was near to 0.4 per cent per degree, while between 700 deg. C. and 1000 deg. C. it was near to 0.6 per cent per degree. Even so, the curve of resistivity in copper, with respect to temperature, may be described as not far from a straight line between 0 deg. C. and 1000 deg. C. The measurements of Dewar and Fleming have indicated that between 0 deg. C. and —200 deg. C. the curve is also nearly the same straight line prolonged.

It is reported that when copper wire is hard-drawn not only is the conductivity reduced, but the temperature-coefficient of resistivity is also reduced. That is, there appears to be some connection between the resistivity and its temperature-coefficient. The resistivity behavior of alloys is certainly in the same direction, for their resistivity is always much higher than that of their pure constituents, while their temperature-coefficient of resistivity is much lower. Both gold and silver appeared to approximate to straight-line resistivity-temperature graphs up to 1000 deg. C., while iron displayed the well-known remarkable discontinuity in the neighborhood of 775 deg. C., where its resistivity rises suddenly with a slight further rise of temperature. After this critical temperature has been exceeded the resistivity resumes a lower gradient. It is very remarkable that at this critical temperature of recoalescence there should be so profound a change in the electric, magnetic, mechanical and metallurgical states of pure iron. Aluminum and magnesium show good straight-line relations up to 550 deg. C., and then increase very rapidly in their resistivity. At the temperature just noted these metals approach the molten state. Carbon, on the other hand, makes a good descending straight line as far as 1000 deg. C., the temperature-coefficient being about —0.02 per cent per degree.

Leaving aside iron and nickel, the graphs of pure copper, silver, gold, platinum, aluminum and magnesium may be described as essentially of the straight-line type, with an average temperature-resistivity coefficient of about 0.37 per cent per degree C., reckoned on the value of 0 deg. C. This means that if the average graph be extended by extrapolation back to very low temperatures it would reach zero-resistivity at —270 deg. C., or very close to the thermo-dynamically inferred zero of temperature. On the other hand, if 0.42 per cent be taken as the ordinarily observed value for pure copper, the inferred absolute zero of copper resistivity would be —238.1 deg. C. The meaning of the term temperature-resistivity-coefficient, as used in this article, differs from that ordinarily used in electrical literature. It may be described as meaning the slope of the resistivity-temperature curve at any assigned temperature, whereas it is ordinarily taken to mean the percentage increase of resistivity per degree C. from and at the assigned temperature. The former definition has certain theoretical advantages in representation or in description while the latter definition has certain practical advantages in computation under industrial conditions. It is not of great importance which definition is adopted at first hand, but it is of great importance to avoid misunderstanding through the ambiguity. The two definitions should give rise to two distinct and separate terms.

A MATTER OF NOMENCLATURE.

Sciences, however remotely they may apparently be allied, often help each other in unexpected ways. An interesting example of this is presented in a recent paper by Dr. Hartmann, the distinguished astro-physicist, dealing with the luminosity of Halley's comet. He desired to express the surface brilliancy of the object in absolute measure instead of following the too frequent custom of indulging in vague generalities and comparisons. Having devised apparatus for reasonably precise comparisons even of the very low intrinsic brilliancies of nebulæ, Dr. Hartmann was discrete enough to turn to the recognized data of technical illumination for the basis of his comparisons, and took as his unit the regular measure of intrinsic brilliancy which would normally be used in German practice—that is, 1 hefner per square centimeter. Now, there is no systematic name for the unit of intrinsic brilliancy, because in lighting techniques intrinsic brilliancy is not measured frequently enough to have created the demand for a unit, and when measured it is expressible in comparatively simple numbers. The intensities with which Dr. Hartmann was dealing, however, were at times only a few thousandths or even millionths of this standard intensity, which condition would naturally lead the investigator to the use of a sub-multiple. Dr. Hartmann, therefore, finding his unit unnamed, appropriated the term *phos* to its use with the systematic set of prefixes, kilo and mega for the multiples, milli and micro for the sub-multiples, all being used in their usual significance.

In terms of these freshly coined units, Dr. Hartmann has given to the world an important investigation of the intrinsic brilliancies of various celestial objects finding, for example, for the nucleus of Halley's comet a surface brightness of the order of 620 mkph, on May 23, while a little later he found that the surface brightness of the ring nebula in Lyra was down to 1.2 mkph. This nomenclature for intrinsic brilliancy having thus made a dignified entrance into astronomical literature, it remains to be seen what reception awaits it in illuminating engineering circles. The term *phos* is one of those which have been advocated for the unit of intensity originally called *pyr* by Professor Blondel, but it is only one of several names thus proposed. There is certainly no valid objection to *pyr*. In fact, it is rather difficult to improve on the systematic units of Blondel's system, the only question being how many of them are needed at the present time for practical purposes. Considering the fact that *phos* has shown its adaptability to astronomical research and has appeared with so distinguished a sponsor as Dr. Hartmann, there seems to be no good reason why it should not take its place in lighting technique as the name of the systematic unit of intrinsic brilliancy, unnamed in Blondel's great paper of 1893. It will be subject, at least for the present, in astronomical and other literature to the same qualification as the lux and the lumen. In Germany the unit of intensity which is preferred is the hefner, while elsewhere

it is generally the international candle; but as the hefner is just nine-tenths of the international candle, a reduction of one value to the other need cause no more confusion in case of the *phos* than in the case of the other units. Until there is final settlement of a scientific unit of intensity we shall have to contend with this difference between German and non-German usage, but this need not in practice discourage the use of systematic units.

MAGNETIC STORMS.

As the effects of disturbance in the earth's magnetic fields are more and more studied they become increasingly puzzling. The old, comfortable generalization that the earth is a colossal magnet was well enough so far as it went, but the cause of the magnetization and the laws which it obeys have escaped detection, while the casual variations in the magnetic elements are exceedingly puzzling on account of their singular time relations. Some of these have been studied with particular care from the standpoint of electromagnetic theory and with particular reference to the possible explanation of some of the magnetic anomalies by the assumption of cathode ray streams on a gigantic scale. We not long ago called attention to the curious delayed action between solar outbursts and magnetic storms, and a recent paper by Dr. Bauer emphasizes the necessity of paying closer attention to the time relations in order to get some clue to the cause of the actions. The particular class of phenomena studied by Dr. Bauer are those apparently having a terrestrial origin, especially the magnetic disturbance coincident with the Mont Pelée eruption of 1902. This eruption brought to light the fact that there is definite progressive development of the magnetic disturbances, which were shown to develop in an eastward course, being felt progressively at various stations to the east and completing the circuit of the earth in about 3½ minutes. A similar disturbance the next year showed a like sequence of manifestation with a period of about four minutes for the complete circuit of the globe.

Analysis of these two cases showed that if the disturbances are produced by electric currents they would have to circulate from east to west if positive and from west to east if negative or such as would be produced by moving negative charges, and that in either case they would have to circulate chiefly in regions far above the earth. Following out this line of investigation, Dr. Bauer has looked into the application of the cathode-ray theory, developed by Birkeland and others, to account for terrestrial magnetic disturbances. The possibility of cathode rays from the sun being the source of electromagnetic anomalies is certainly a very attractive one, although perhaps not in the least necessary to an explanation of the facts. In other words, it is only one of several hypotheses, the validity of which must be tested by physical facts. Dr. Bauer following up the study of the two cases investigated, found in examining the possible effect of cathode rays coming from the sun that if they entered the earth's magnetic field from without they would be deflected to the wrong direction to account for the observed phenomena. If the corpuscular explanation applies to this particular case, one would have to assume corpuscles shot out from the earth instead of from the sun, not upon its face an impossibility even considering the volcanic disturbance coincident with the first of the cases investigated. Unfortunately, if the stream of charged corpuscles is such as would agree with the time taken by the disturbance to go clear around the earth, the orbit of the corpuscle stream would have to be something over 2,000,000 miles from the earth, which pretty effectively eliminates this particular hypothesis.

Dr. Bauer states very conservatively that it is not possible to state definitely whether the initial cause of the disturbance coincident with the Mont Pelée eruption was terrestrial or solar, but the natural inference would be that the coincidence was of a character to determine with a very high degree of probability the terrestrial origin of the effects observed. The results found for these particular cases are emphatically against the solar-cathode-ray theory of Professor Birkeland. They do not, however, invalidate his hypothesis for the explanation of other phenomena, which must be taken up upon their merits. It is not in the least necessary, in fact, to suppose that all the electromagnetic effects observed in and about the globe are due definitely to a single cause. Any great disturbance of the earth's crust, considered as part of an irregularly magnetized body, may be expected to disturb the magnetic conditions, however produced, and to initiate a sequence of magnetic phenomena lasting until the mechanical disturbance has been quieted. On the other hand, as regards external disturbing causes, it is quite certain that a sufficiently violent electromagnetic change at the sun is competent to produce measurable terrestrial effects quite irrespective of the existence or non-existence of cathode-ray effects, however important these latter may prove to be. A study of the time relations involved may give a reasonable clue to the separation of the phenomena into groups dependent on one or another active cause, but so far as the investigations upon the subject have gone, there is not the slightest reason to suppose that all variations in the earth's magnetic field and the electrical conditions surrounding the earth are due to any one particular exclusive cause. All the facts point to an intricate series of perhaps interrelated causes rather than to the sole action of any one. A more complete co-ordination of magnetic observations with respect to time is needed before the data for conclusive examination of the current theories are at hand.

The attractive feature of Professor Birkeland's cathode-ray hypothesis is that it accounts simply and consistently for many cases of delayed action between solar and terrestrial phenomena; and, the earth being only a little over a hundred solar diameters distant, the existence of cathode streams reaching even to the earth's vicinity seems plausible enough. On the other hand, even in this case there is no certainty yet that the tremendous electromagnetic effects known to exist at the sun's surface are really coincident with their conspicuous appearance on the surface of the photosphere. That is, there is a possibility that the apparent lack of coincidence in the time relations between solar and terrestrial magnetic upheavals may be only apparent, so that the phenomena could be accounted for without invoking the relatively slow motion of cathode rays. The whole matter is as yet undetermined and perhaps the final criterion as regards cathode action will have to be looked for, not in the elements of terrestrial magnetism, but in the auroral phenomena, which Professor Birkeland is already investigating, and in astronomical investigations relating to the distribution of material particles in extraterrestrial space.

Convention of American Street and Interurban Railway Association.

The annual convention of the American Street & Interurban Railway Association will take place at Atlantic City, N. J., Oct. 10 to 14. Three halls located on Young's Million Dollar Pier have been provided for the meetings, and in addition suitable rooms are available for meetings in the Marlborough-Blenheim and Traymore hotels. All of the meetings of the American Association and of the Transportation and Traffic Association will take place in the Greek Temple near the outer end of the pier. The accountants will hold all their meetings in the Annex Court Hall, midway between Aquarium Court Hall and the Greek Temple. The sessions of the Engineering Association on Tuesday and Wednesday will be held in Aquarium Court Hall, near the Boardwalk end of the pier, and the Friday sessions will be held in the Greek Temple. No session of the Engineering Association is scheduled for Thursday, that day being set apart for the inspection of exhibits. The claim agents will hold all their sessions at the Traymore Hotel. The Manufacturers' Association has arranged for exhibits on the Million Dollar Pier, and adjacent to the pier and along the Boardwalk considerable space will be used for an extensive display of electric railway cars. The entertainment features include the annual reception in the ballroom on Young's Million Dollar Pier on Monday evening; a smoker, entertainment and indoor baseball game for the railway and supply men on Tuesday evening, and a progressive euchre party for the ladies on Tuesday. The annual amateur vaudeville and theatrical performance will be given on Wednesday evening, and a promenade concert and ball on Thursday evening. In addition the ladies will be guests at several afternoon entertainments during the week. A golf tournament will take place at the Country Club of Atlantic City on Thursday. This will be open to all delegates and guests, and a clock golf contest has been arranged for the ladies on Wednesday afternoon.

Annual Convention of the Illuminating Engineering Society.

The fourth annual convention of the Illuminating Engineering Society will be held at Johns Hopkins University, Baltimore, Md., Oct. 24-25. The convention will open in McCoy Hall at the university at 10 o'clock on Monday, Oct. 24, and there will also be an afternoon sesssion at 2:30 o'clock. There will be two sessions on Oct. 25 at 10 o'clock in the morning and 2 o'clock in the afternoon respectively. The following is the list of papers to be read and the authors: *The Value of Illuminating Engineering to the Manufacturer,* by Mr. V. R. Lansingh, of New York; *Practical Value of Illuminating Engineering to the Central Station,* by Mr. John F. Gilchrist, of Chicago, Ill.; *The Value of Illuminating Engineering to the Commercial Man,* by Mr. W. J. Serrill, Philadelphia, Pa.; *Illuminating Sheets for the Calculation and Recording of Data,* by Mr. J. S. Codman, Boston, Mass.; *Central-Station Illuminating Engineering Department Work and Methods Applied by the Denver Gas & Electric Company,* by Mr. C. F. Oehlmann, Denver, Col.; *The Relations Between Pressure and Light Output with Various Gas Lamps and Burners,* by Mr. Norman Macbeth, Gloucester, N. J.; *The Temperature Rise Due to the Energy Radiated in the Lower Hemisphere from Different Light Sources,* by Messrs. J. G. Felton and E. J. Brady, Philadelphia, Pa.; *Some Spectral Luminosity Curves Obtained by Flicker and Equality-of-Brightness Photometers,* by Dr. Herbert E. Ives, Cleveland, Ohio; *An Unrecognized Aspect of Street Illumination,* by Mr. Preston S. Millar, New York; *The Effect of Light on the Movement of Lower Organisms,* by Prof. S. O. Mast, Baltimore, Md.

Following the convention a course of thirty-six lectures on illuminating engineering will be given at Johns Hopkins University. The subject and scope of the lectures have been proposed by the society and approved by the university. The lecturers have been invited by the university upon the advice of the society. An outline of the lecture course was given in the first issue for June 1910.

Among the entertainment features will be an automobile ride for the ladies through the suburbs of Baltimore during the afternoon session on Monday. At 8 p. m. there will be a public lecture in McCoy Hall, to be followed by a reception and view of the apparatus used in the lecture course. The reception will be held in the physical laboratory of the university. A trolley trip has been planned for Tuesday for the ladies, starting at 10 a. m. After a trip to points of interest the cars will carry the party to the Baltimore Country Club, where luncheon will be served at 12.30. A subscription banquet will be given on Tuesday at 7:30 p. m. to both gentlemen and ladies in attendance at the convention in the large banquet hall of the Hotel Belvedere.

Meetings of the A. I. E. E.

The two hundred and fifty-second meeting of the American Institute of Electrical Engineers, marking the opening of the season of 1910-1911, will be held in the Engineering Societies Building, 33 West Thirty-ninth Street, New York City, on Friday evening, Oct. 14, 1910. A paper entitled "Potential Strength in Dielectrics" will be presented by Messrs. Harold S. Osborne, of the American Telephone & Telegraph Company, and Harold Pender, professor of theoretical and applied electricity, Massachusetts Institute of Technology, Boston, Mass.

A public engineering meeting will be held in the Engineering Societies Building on Monday evening, Oct. 17, 1910, at 8 p. m. for the discussion of the subject, "Rapid Transit Requirements of Greater New York." An informal paper will be presented by Mr. Frank J. Sprague, past-president of the Institute and chairman of the railway committee of the A. I. E. E. A brief statement will be given of the general facts pertaining to routes and construction and equipment of the existing and proposed subways, illustrated by lantern slides. The meeting is to be an informal one, intended to afford opportunity for the expression of engineering views upon a subject of much importance.

Reports of the Board of Supervising Engineers, Chicago Traction.

For the fiscal year ended Jan. 31, 1909, the board of supervising engineers, Chicago Traction, has issued its second annual report, which makes an imposing volume of 522 pages, with many illustrations, maps and diagrams. With this book is issued an "Advance Report" of the same body, presenting financial and statistical information for the year ended Jan. 31, 1910, being a part of the third annual report, not yet issued in full. In a prefatory note to this "Advance Report" the board of supervising engineers explains, under date of Sept. 23, 1910, that the compilation of the annual reports published by the board, giving comprehensive descriptions of the construction and rehabilitation work performed by the street-railway companies of Chicago under its supervision, requires months of preparation, which has caused these reports to be somewhat delayed. Therefore, in advance of the appearance of the third annual report certain financial and statistical information relating to the fiscal year ended Feb. 1, 1910, which will be covered by that report, is issued and presented with the second annual report.

The board of supervising engineers consists of Mr. Bion J. Arnold, chairman; Mr. George Weston, representing the City of Chicago; Mr. Harvey B. Fleming, representing the Chicago City Railway Company; Mr. John Z. Murphy, representing the Chicago Railways Company, and Mr. A. L. Drum, representing the Calumet & South Chicago Railway Company. Mr. F. K. Parke is the secretary of the board and Mr. L. H. Davidson is the assistant secretary. Beside the companies mentioned the Southern Street Railway Company is also under the supervision of the board.

There are really two boards, Board No. 1. embracing the work of the Chicago City Railway Company and the Chicago Railways Company, and Board No. 2, having jurisdiction over the work of the Calumet & South Chicago Railway Company. Messrs. Arnold, Weston, Fleming and Murphy constitute Board No. 1, and Messrs. Arnold, Weston, Drum and Fleming constitute Board No. 2.

It is shown that on Jan. 31, 1910, the total value of the properties of the three companies named in the preceding paragraph, and also of the Southern Street Railway Company, was $98,529,977.96. Of this large amount the largest item was the value of track, amounting to $23 486,045.38, while cars, which come next, were valued at $11,519,526.67. The value of power plant equipment is comparatively a small item, being $4.894,178.64. This is undoubtedly due to the fact that the street-railway companies of Chicago are large purchasers of electrical energy from the Commonwealth Edison Company. Electric equipment of cars, however, is valued at $6,095,054.74.

The gross receipts of the four companies named for the year ended Jan. 31, 1910, were $22,832,882.64, and the total operating expenses $15.983,017.84. The largest item of expense was the operation of cars, which cost $6,701,433.31 for the year. The operation of generating plants cost $2,496,077.13, the item of purchased energy being $1,794,499.15. Under the provisions of the traction settlement ordinances the City of Chicago receives 55 per cent of the net receipts after 5 per cent interest on capital invested is deducted from the net receipts from operation. The city's proportion of these "net receipts" for the year mentioned was $1,276,252.65.

The total value of the properties of the Chicago City Railway Company on Jan. 31 last was $38,507,294.18; Chicago Railways Company, $51,851,308.97; Calumet & South Chicago Railway Company, $6,931,278.82; Southern Street Railway Company, $1,240,095.99.

The figures given above are obtained from the "Advance Report" for the year ended Jan. 31, 1910. The second annual report of the board, covering the year preceding that, is a veritable mine of useful information relating to the engineering, economic and financial features of the great work of rehabilitating the surface street railways of Chicago under the ordinances of Feb. 11, 1907; March 30, 1908, and June 29, 1908. There is not only a general account of the work done by the board, but also exhaustive treatment of the various departments of the work. These varied "exhibits" relate to such subjects as pay-as-you-enter cars; ventilation of street cars; chemical treatment of ties; installation of through routes; publicity of accounts; track and roadway; electric energy distribution; building and fixtures; generating plant equipment; cars, equipment and operation, and tunnels.

Pueblo Fire-Prevention Ordinances.

The City Council of Pueblo, Col., has passed four ordinances relating to the prevention of fire as follows: An electrical ordinance requiring conduit for permanency in the inner fire limits, embracing the main conflagration areas of the city; a gasoline lighting ordinance, providing for outside tanks and for outside generators except in dwellings; an ordinance restricting storage of gasoline, gunpowder and other explosives, and an ordinance regulating the disposition of rubbish, waste, etc. The latter ordinance also requires all new buildings exposed by other buildings to have fireproofed windows in order to prevent conflagration.

Upon the passage of these ordinances Mr. W. J. Canada, electrical engineer of the Rocky Mountain Fire Underwriters' Association, made the following statement to the Council:

"Besides the flat reduction on Pueblo's insurance rate already in force, each building owned and occupied where these ordinances are observed will receive a direct additional benefit of any charge in insurance rates for defective construction which these ordinances prohibit. Where charges in rates for hazardous wiring, gasoline lighting, rubbish, building exposures or other such conditions now exist, the improvement of these buildings to place them in accordance with the new ordinances will remove the charges. As these ordinances will reduce the causes and numbers of fires, they will prove at least the equal of additional fire-fighting equipment in reducing fire losses."

Removal of exposures in existing buildings and some additions to fire-fighting equipment are strongly recommended by the Council as set forth in the recent report on Pueblo by Mr. Canada.

Commemoration of the Invention of the Electric Motor by Davenport.

In the midst of the rapid advance of a great art and industry historic perspective is not seldom lacking. The pressure of daily applications tends to obscure the significance of pioneer discoveries and inventions, and the ready acceptance of hard-earned achievements as stepping stones toward a larger influence in the affairs of men often blinds an entire profession to the epoch-making work of its originators. Gradually, however, as an art assumes a world-wide scope and as the value of precedent begins to receive its due recognition those who look deeply into the causes of development recognize the significance of achievements which, while little appreciated by the world at large, constitute the foundations of modern triumphs and illustrate conceptions which were far ahead of their times. Appropriate commemoration logically follows, and if by some dignified and enduring mark a milestone is set up beside the highway of progress, the result must inevitably be the enrichment of the record of the art for those who practise it and the spread of an enlightening influence upon all who visit the community.

Thomas Davenport.

Considerations like these characterized the recent annual meeting of the Vermont Electrical Association, which was held at Brandon, Vt., on Sept. 28 and 29, 1910, close by the home of Thomas Davenport, inventor of the electric motor. The meeting was the association's ninth, and in conjunction with the New England Section of the National Electric Light Association and the Vermont Historical Society the occasion was made memorable by the dedication of a tablet in honor of the inventor, who in 1834 built the first electric motor which the world had ever seen. The tablet was unveiled in the village of Forestdale on the site of Davenport's remarkable labors, and the interest of the occasion was heightened by the presence of several direct descendants and near relatives of the inventor, and by a representative gathering of electrical men of distinction, including President W. W. Freeman, Executive Secretary T. Commerford Martin, and New England Section President Alex. J. Campbell, of the National Electric Light Association. Honored places were occupied by Rev. W. G. Davenport, of Washington, D. C., son of the inventor; Rev. W. R. Davenport, Bellows Falls, Vt.; Mr. William S. Davenport, New Bedford, Mass., inventor and manufacturer of a multiple automatic screw machine; Mr. Henry A. Davenport, Putnam, N. Y.; Hon. H. F. Field, Rutland, Vt., former State Treasurer of Vermont; Miss Frances Davenport, Washington, granddaughter of the inventor;

Mrs. Hattie Vaughan, Mrs. G. MacIver and Mrs. H. W. Kingsley, Rutland, Vt., and Mrs. J. D. Kingsbury, Bradford, Mass., all bound to Thomas Davenport by close family ties. Ex-Governor Stickney, of Vermont, represented the Vermont Historical Society, and President C. E. Parker, of the Vermont Electrical Association, occupied the chair. Mr. E. D. Blackwell, of Brandon, was chairman of the committee on arrangements, the other members being Messrs. George S. Haley, of Rutland, and C. C. Wells, of Middlebury.

Headquarters were maintained by the association at the Brandon Inn. To enable the dedication to be generally celebrated Sept. 28 was named "Davenport Day," and business was largely suspended during the exercises at Forestdale. The local merchants exhibited tasteful electrically illuminated window decorations, and around the park in the center of Brandon were installed about 200 2-cp incandescent lamps with red, white and blue colored bulbs. The Vermont Electrical Association also had an electric sign of 135 lamps in operation at the main entrance of the hotel, energy being supplied by the Neshoba Electric Company. By the courtesy of the residents of Brandon and its vicinity, the party was transferred from the hotel to Forestdale, a distance of about three miles, by automobiles. The morning of the 28th was devoted mainly to social uses, a short executive committee meeting being held before lunch, at which the prospects of a closer relationship with the national organization were favorably considered.

The unveiling exercises were held on a small stand decorated with the national colors just outside the Davenport house in

Davenport Memorial Tablet.

Forestdale, the site of the house being nearly covered by an American flag. Music was furnished by the Brandon Cornet Band of twenty-four pieces, a feature being a march composed in honor of Thomas Davenport. About 500 persons were present when President Parker introduced the Rev. W. G. Davenport, of Washington, D. C., who invoked divine blessing, giving thanks for the mysterious powers of Nature and for the men who have been led to chain them for the benefit of the human race.

President Alex. J. Campbell, of the New England Section, N. E. L. A., then presented the tablet, pointing out that although history of the most stirring kind had been made in the Green Mountains, history no less important is being made today in the building of a great industrial democracy, bringing about the equality of man. He said that it was fitting that Thomas Davenport should have aided in the creation of this industrial democracy, and that such men are as true contributors to history as those who risk their lives in warfare. He presented the deed of the tablet to the Vermont Historical Society as a monument to an indomitable spirit and a mind that persevered. In accepting, ex-Governor Stickney emphasized the meed of honor due to men in all walks of life and the benefits of rescuing from oblivion the acts of the world's great workers. Pinched by poverty and with limited means for experiment, Davenport by singleness of purpose succeeded in making an invention of great benefit to the world.

The unveiling of the tablet was then performed by Miss Frances Davenport and Mrs. Alex. J. Campbell. The tablet is a handsome bronze plate with raised letters, carried upon a block of native Vermont marble about 5 ft. high and 3 ft. wide. It stands at the side of the Brandon-Rochester highway near the front of the old Davenport home and bears the following inscription:

IN MEMORY OF
THOMAS DAVENPORT
1802———1851

THE INVENTOR OF THE
ELECTRIC MOTOR

NEAR THIS SPOT STOOD THE
BUILDING WHERE HE DEVELOPED
HIS INVENTION

THIS TABLET IS PLACED HERE BY
ALLIED ELECTRICAL ASSOCIATIONS
IN AMERICA IN RECOGNITION OF THE
GREAT SERVICE RENDERED MANKIND
BY THE INVENTOR, TO THE DEVELOPMENT
OF WHICH HE DEVOTED HIS LIFE.

ERECTED SEPT. 28, 1910.

A masterly appreciation of the achievements of Thomas Davenport was then presented by Mr. T. Commerford Martin. Mr. Martin paid a high tribute to the influence of New England upon American invention, and in graphic phrases touched upon the work of Franklin, Morse, the two Fields, Sprague, the Wallace family, Farmer and Thomson, with brief reference to the accomplishments of Alexander Graham Bell and Edison on New England soil. A. B. Chandler and C. A. Tinker were also cited as natives of this section who have brought distinction to it, and the name of Thomas Davenport, the blacksmith of Brandon, was added with emphasis to the list of those who have wrought with great influence upon the electrical world. The speaker reviewed the career of the inventor with keen appreciation of his difficulties and enthusiasms as the first American patentee of the electrical motor, the first man in all time to apply electric power to the operation of railways, and the first man in the world to hitch together those tremendous forces, electricity and the printing press. Seen from the industrial standpoint it is significant that if the Davenport patent were enforced today it would embrace every one of the millions of electric motors in use in the United States, whose royalties would constitute an income equal to anything enjoyed by Carnegie or Rockefeller. It would have been a merciful dispensation if the bitter bread of struggle and disaster eaten all the years of his short life by this extraordinary genius, this prophetic village blacksmith, could have been sweetened with the merest modicum of the vast wealth that his glowing conceptions have helped to create for the benefit of us all.

Mr. Martin sketched the meager education available for the inventor, and passed rapidly through his early career, leading to an absorbing interest in the "galvanic magnet" of Henry, and his securing of an electromagnet and batteries of his own. The flash of insight which revealed the availability of power from an electromagnetic source, the material curse of experiment in its effect upon domestic prosperity, the pathetic cutting up of her silk wedding dress by his devoted young wife to sup-

ply insulating materials for the building of the motor, the support given Davenport by Professor Turner, of Middlebury College; Mr. Ransom Cook, of Saratoga Springs; Mr. Orange A. Smalley, of Forestdale; President Eaton, of the Rensselaer Polytechnic Institute; General Van Rensselaer, of Troy, and Prof. Joseph Henry, and finally increasing financial disasters, were chronicled in sufficient detail to bring the personality of the inventor vividly into relief. Reference was made to Davenport's work in the production and sustaining of piano-string vibration of electromagnets, and his inventions improving primary batteries.

When Davenport came upon the scene Faraday and Henry had already done their great work and the principles of the electric generator and the electric motor had been clearly perceived and enunciated. Yet there were no real motors before Davenport's time, and had the dynamo been known his work would have been carried to instant fruition. Davenport and others much later failed because they had no ready source of cheap power, and because the reversibility of the motor was unknown. Energy produced by battery is at least twenty times as costly as that produced by coal through the medium of a steam engine and a dynamo. All the electrical arts except telegraphy were held back by the absence of cheap power. When Davenport told the great Joseph Henry that he proposed to build his motors up to 1 hp, the cautious philosopher warned him to "go slow," and hinted that electricity could not compete with steam. Brief reference was made to the contemporary work of Dr. Jacobi in motor construction and its limitation by the absence of abundant and inexpensive power. Mr. Martin said that it was astounding that at a time when his native State had not a single mile of steam railroad Davenport built his little model of an electric railway and asserted that that was the best way to do it. Mr. Martin then referred to the breadth of Davenport's patent claims and the far-reaching character of his fundamental definitions, which included the statement that the principle of his invention "was the production of rotary motion by repeated changes of magnetic poles." Writing of Davenport's work fifty years later, in 1891, Mr. Franklin L. Pope, the leading electrical patent expert and littérateur of his day, said: "If this patent, which expired in February, 1851, were in force to-day it is not too much to say that upon a fair judicial construction of its claim every successful electric motor now running would be embraced within its scope."

In conclusion Mr. Martin reviewed the application of the principle of the commutator by Davenport in the 1835 motor, the building of the model electric railway, embodying incidentally the idea of a central-station source of supply and the use of a track-return circuit, and touched upon the fate of representative Davenport equipment which had been destroyed by fire or carried to the bottom of the sea, and Davenport's heroic efforts to raise funds by means of exhibitions and lectures and his pioneer work in trying twice to establish a technical journal, not only devoted to electricity and magnetism, but actually printed by electricity. The *Electro-Magnet and Mechanical Intelligencer* and the *Magnet* of 1840 were little quarto sheets, but they were the first of their kind in America and probably the first in the world, and made Davenport the father of electrical journalism. His record is astounding and unimpeachable. Struggling against adversity, dying in poverty, and long obscured by forgetfulness, this modest, simple son of Vermont stands forth as conspicuous as one of her granite mountains among the immortals who for the benefit of their fellow men have tamed and utilized the lightnings of the Almighty.

On the evening of Davenport Day an informal gathering was held at the Brandon Inn, and reminiscences of the inventor were given by relatives, with remarks by others present. Among the speakers were: Rev. W. G. Davenport, President W. W. Freeman, N. E. L. A.; Mr. A. J. Campbell, Mr. H. T. Sands, ex-Governor Ormsby, of Vermont; Mr. Henry F. Field and Mr. E. D. Blackwell. On Sept. 29 a barbecue was held at Lake Dunmore. Baseball, rowing and running races with other sports filled the day.

Association of Railway Electrical Engineers.

The third annual convention of the Association of Railway Electrical Engineers was held in the Hotel La Salle, Chicago, Sept. 27 to 30. Mr. E. M. Cutting, of Oakland, Cal., president, was in the chair at the opening session. The total convention attendance was about 400, of whom perhaps 150 were active and associate members, including some of the best known men among the electrical engineers of the leading steam roads of the country.

In his opening address President Cutting referred to the proposal to hold the regular meetings at Atlantic City and put himself on record as opposed to it on account of the tendency of delegates to spend their time sight-seeing instead of at the meetings. He also stated his objections to merging with the Master Car Builders' Association on the ground that it would completely overshadow the electrical engineers 'association and make rapid and effective action almost impossible.

The report of the secretary-treasurer Mr. G. B. Colegrove, showed a membership of 486, with expenditures of over $2,900 during the year.

ILLUMINATION.

The report of the committee on illumination, of which Mr. H. C. Meloy was chairman, was read by Mr. J. R. Sloan, electrical engineer of the Pennsylvania Railroad. The committee noted the improvements in incandescent electric lamps adopted for car lighting, and referred to the new drawn-wire filament of the tungsten lamp as perhaps the most interesting recent advance. This lamp gives a long, useful life and is sufficiently strong mechanically to fulfil the conditions demanded by train-lighting service. It is noted that one year ago only one railroad had standardized the tungsten lamp to the exclusion of all other types, while to-day practically all the railroads in the country are using the tungsten lamp with entire satisfaction.

The committee recommended that the two standard ranges of voltage for car-lighting lamps be continued; that is, from 28 volts to 34 volts, and from 57 volts to 65 volts, inclusive. It was also recommended that the use of lamps having other than round bulbs be abandoned as soon as possible.

Various standard carbon, tantalum and tungsten lamps were recommended as the result of conferences which have been held with the lamp manufacturers.

Some information and data were also given by the committee in relation to lamps made for general illumination as well as those designed for car lighting.

In relation to the variation of life with the impressed voltage, curves were given to show that the tungsten filament is the most stable in this respect. For example, when operated at a voltage 8 per cent above normal the tungsten filament has its life shortened to 35 per cent of its normal value, while for the same variation in voltage the life of the tantalum and carbon filaments is reduced to 29.5 per cent and 21 per cent of normal respectively.

The discussion of this report was opened by Mr. H. Schroeder, of the General Electric Company. He referred to the question of drawn-wire, ductile tungsten filaments for car-lighting lamps and stated that while the present development of this filament does not justify putting them on the market it does indicate that a satisfactory lamp will soon be developed. He also described the drawn-wire filament and showed the difference between the two types by describing the processes of manufacture in a general way. He said also that 1000 hours is considered a good life for lamps in general and showed how the life can be increased by using high-voltage lamps on low-voltage circuits.

In response to the request of Mr. D. J. Cartwright, electrical engineer of the Lehigh Valley Railroad, for information on series tungsten versus multiple tungsten for lighting railroad yards, Mr. Schroeder stated that the series tungsten lamp is longer lived, due to the larger cross-section of the filament used, and that the series system is a good one to install where all of the lamps are to be in use continuously when a constant-current transformer is installed. He added that experience

showed the life of series lamps to be from 2000 hours to 3000 hours against from 1000 hours to 1500 hours for multiple lamps, so it is a question of lamp renewals against the cost of a transformer and whether there is a multiple circuit already in use.

Mr. R. S. Carrick, of the Tipless Lamp Company, New York, said that there are two objections to the ductile-filament lamp—high cost and short life—but that satisfactory ones will undoubtedly be developed in the near future.

Mr. A. J. Farrelly, of the Chicago & Northwestern Railroad, asked if any of the members present had had any experience with tungsten lamps of from 100 watts to 500 watts for station lighting. He said he would use them in the new terminal station of his company in Chicago.

The matter of etching the name of the owners on the lamps was brought up and the discussion brought out the fact that this practice prevents many losses. Some users stamp their own initials or other symbol on their lamps instead of paying the makers for doing so. While etching does not prevent all stealing of lamps it does deter many who do not like to run the risk of people seeing such lamps in their houses, although some are willing to take the chance.

Mr. C. R. Gilman, Chicago, Milwaukee & St. Paul Railroad, asked if any of the members could give any data on the life of tungsten lamps in actual service, but no one could do so. Mr. Gilman then stated that he had found lamps giving over 1000 hours' life in service on his road, although only a few are in use. Mr. Cartwright stated that he had observed some 100-watt lamps in stations which had been burning 1700 hours. He said also that by putting tungsten lamps on the cars they had been able to use old batteries that were so nearly worn out that they would have to be replaced if carbon-filament lamps were used. Mr. J. R. Sloan, of the Pennsylvania Railroad Company, stated that when the management of his company refused an appropriation for additional battery-charging equipment a year ago the difficulty was overcome by using the tungsten lamps in place of carbon ones.

At the Tuesday afternoon session, when the discussion was resumed Mr. Gilman stated that he had always found it more economical to protect the eye from the light by using a shade on the lamp than by using frosted globes. While there are certain conditions that call for frosting for decorative effects general car lighting does not require their use. He stated also that where 8-cp lamps were equipped with shades in place of 16-cp lamps without them, making no other changes, better light and more satisfactory illumination were obtained.

Mr. Farrelly mentioned another feature of car illumination which he called "an indiscriminating public." He told of several cases where complaints had been made by people regarding the lighting when the trouble was merely one of comparison, the properly lighted car being the one criticised because it was not so bright as some other which was really too brightly lighted.

Mr. Hancock, chief electrician of the Queensland Government Railways, Australia, stated that his road had experienced a great amount of trouble with some glass shades because of dirt settling in the grooves and reducing the efficiency of the shades. He stated also that he had found these shades very fatiguing when they were within the range of vision and asked if any of the other members had observed the same effect. The opinions of several of those present were that fluted or ribbed shapes diffuse the light so well that there is no cause for complaint when the proper type of shade is used in each instance.

The discussion then turned toward the proper place to locate lamps, some of the members advocating placing them along the center of the deck and on the deck rail, others stating a preference for the deck and just over the windows, while still others advocated the deck rail alone. It was generally agreed that dining-cars require different treatment from parlor-cars and day-coaches.

INCANDESCENT LAMPS.

Mr. J. R. Sloan read that part of the report of the committee on specifications referring to incandescent lamps. The committee recommended methods of ordering lamps and various specifications as to bulbs, bases, filaments, leading-in wires, vacuum, etc. It was stated that the value of the unit of candle-power shall be that maintained by the Bureau of Standards on Jan. 1, 1909. Provisions are made in the specifications for photometric measurements, inspection and tests. All packages of accepted lamps shall be stenciled by the inspector with a serial number commencing at 1 at the beginning of the year. and continuing consecutively until the end of the year. Tables were given to show the initial rating and performance of carbon-filament, metalized-filament, tantalum-filament and tungsten-filament lamps.

In the discussion Mr. Schroeder stated that the clause in the report which reads "the inspector shall examine 10 per cent of each lot of lamps" is difficult to apply when a large lot of lamps is received. He suggested that some sort of sliding scale be used whereby a smaller percentage of lamps be tested as the size of the shipment increased, asserting that a fair average could be obtained.

Referring to the tables shown, Mr. Schroeder suggested that they be brought up to date with the new international standard ratings and that the lamps be rated in total watts instead of candle-power. He suggested also that the limits on tungsten filament lamps should be changed, substituting "watts per candle, maximum only," in place of "watts per candle, per cent above and below rating." This suggestion was based on the great improvements being made in lamps by the makers and was made because the roads would be apt to copy the tables from the proceedings for use in their instruction books.

Mr. Sloan suggested that the report be referred back to the committee without further reading and that it should have a general revision. After some discussion as to how the report was to be handled and approved it was referred back to the committee, which was advised to get some of the lampmakers to confer with it in order that the report might be as complete and up to date as possible.

CAR LIGHTING IN AUSTRALIA.

The president then called upon Mr. S. H. Hancock to make some remarks about car lighting and electrical work in Australia. Mr. Hancock prefaced his remarks by stating that each state government there owns the roads and that no two of the roads are of the same gage, so there is no interstate traffic over one another's lines.

Gas-lighted trains have been most used in Queensland until recently, and now electrically lighted trains are being run on many of the lines. The adoption of electricity was retarded to a great extent by the belief in the necessity of having a gas auxiliary outfit on board to use in case of emergency, but this has been changed now. Owing to the running of mixed freight and passenger trains on branch lines it has been hard to get electrically lighted trains in very general use excepting on main lines. In New South Wales, the oldest state in the country and also the most densely populated, electric lamps have been used for about ten years on some of the lines. Use has been made of both straight storage-battery and axle-generator systems, but none of them has been very satisfactory, and hence only a few of the express trains have electric light regularly. In Victoria, the smallest state gas is used exclusively, and it will not touch electricity on account of the large amount of money invested in gas outfits. The states of South Australia and West Australia have both adopted electrically lighted trains.

Mr. Hancock had considerable to say regarding the use of gas auxiliaries, and showed very clearly that other countries are watching the United States for an example to follow. He urged the association to take a definite stand against gas.

In the discussion which followed these remarks it was brought out that on several lines where gas was available the men did not take such good care of the electrical outfits as they should, depending on the gas in case of trouble during the run, but that complaints almost disappeared after the gas outfits had been removed and the men were compelled to rely on the electrical equipment. The Pullman company now puts no gas on any of its electrically lighted cars, and other builders are following this example.

After extending a vote of thanks to Mr. Hancock for his kindness in addressing the association, the meeting adjourned for the day.

ACCOUNTS AND REPORTS.

At Wednesday morning's session the report of the committee on accounts and reports was read. This report, which was presented by Mr. F. R. Frost, chairman of the committee, showed the great need of a standard method for calculating and reporting the cost of car lighting. Many reports are submitted without explanation and are incomplete, so the committee endeavored to devise a standard and simple method to overcome this difficulty. When considering dissimilar methods of lighting all items of expense should be included, and to make such comparison complete the figures should be reduced to a standard, based on total effective illumination and hours of lighting. This would require more time and testing than circumstances usually permit.

It was recommended that comparative reports of cost of maintenance and operation for similar systems include no allowance for interest and depreciation, for power for operating head-end systems or axle generators, for haulage of electrical apparatus or for insurance and taxes, as it is difficult to settle upon a satisfactory basis for calculating these items. Sufficient data should be given, however, to enable the engineers to make their own allowances.

Depreciation on account of obsolescence is viewed with considerable difference of opinion, but the committee believes that an allowance sufficient to replace the equipment in ten years should be made. No depreciation should be allowed on articles replaced at intervals with material of latest design charged as renewals.

During the discussion on this paper Mr. Cartwright questioned the advisability of taking either interest or depreciation into account, because the only point of interest to the association in this matter is the cost of lighting passenger cars per car-month or per 1000 miles. He then presented some figures made as the result of records kept on twenty-one cars for a period of nearly two years. These covered the actual cost of material and labor necessary to make repairs and keep the cars in operating condition, in so far as the electrical lighting equipment was concerned, and included lamps, fuses, belts, generators, regulator parts, storage batteries and miscellaneous fittings. The average was $10.97 per car-month for material and $10.39 per car-month for labor, including one new equipment and damages by wrecks.

There was a great deal of discussion and much difference of opinion as to how the cost of energy for lighting should be determined, because of the many systems in use and the wide variations in operating conditions and cost of fuel. The consensus of opinion favored omitting the cost of energy generation when axle or head-end systems are used because there is no appreciable increase in steam consumption.

STANDARDS.

The report of the committee on standards was presented by Mr. C. R. Gilman, of the Chicago, Milwaukee & St. Paul Railroad, chairman of the committee. This showed in a general way what has been done toward adopting the recommendations of the committee of 1909. Investigation showed that most of the recommendations had been put into practice and many of the devices mentioned put into use.

The following recommendations, made last year but not yet adopted as standard, were proposed by the committee:

(1) That all cars assigned or interchanged with head-end lighted roads be provided with three-line train main wires and the G-3 connectors. (2) That storage-battery boxes be placed in the center of the car. That they be made of iron, bottoms lined with wood and inside of box be protected with a heavy coating of acid-resisting paint. (3) That all cars carrying storage batteries be provided with two charging receptacles of a carrying capacity of 65 amp. (4) That all wiring under cars be placed in iron conduits. (5) That a fuse block, enclosed in an iron moisture-proof box, be placed just outside of the battery box, same to contain two 150-amp knife-blade fuses. (6) That the rules of the Fire Underwriters shall cover all car wiring. (7) That knife-blade N. E. C. type fuses be used for all fuses of 31 amp and above, the ferrule type for 11 amp to 31 amp, and the screw type for 10 amp and less. (8) That all parts of suspension gear of axle equipment should clear any part of the car body 3.5 in. and that same gear clear the track 6 in. when the car stands level. (9) Suspension gear to be so designed that the armature can be easily removed. (10) When facing the end of the truck on which the generator is mounted, that the pulley be on the right-hand side. (11) That a straight pulley seat be provided on the axle. It is recommended that a bushing or sleeve secured to same be used. Dimensions for bushing to be 7.5 in. external diameter and 8.5 in. long, turned straight. That the pulley hub have an internal diameter of 7.5 in., bored straight, the length of the hub to be 6.5 in. and the face be straight—9 in. or wider if flangeless or 8 in. wide if flanged. (12) That the generator pulley be 8 in. face, flanged, and the face crowned and perforated. That a flanged pulley with a perforated crowned face 8 in. wide be used on the generator. (13) That each electrically lighted car be provided with a framed diagram of the wiring, placed in a conspicuous place.

The report referred also to the recommendation of the Master Car Builders' committee on car lighting, which is as follows: "Section 10. That where axle generators are used negative, positive and generator field leads shall be fused as close as possible to the generator, either at the joint at which these leads enter the conduit or where they are secured to the bottom of the car. The above fuses are to be for emergency service only and to be at least 100 per cent above the capacity of the fuses on the switchboard protecting the same leads." The committee disagreed with this recommendation and earnestly desired careful consideration and discussion of this point.

The discussion of the report was very pointed and resulted in the appointment of a committee to confer with the Master Car Builders on the general subject of train lighting. Mr. Cartwright was made chairman. The M. C. B. committee has expressed its desire to confer with the Association of Railway Electrical Engineers on all matters of mutual interest and to help in any way possible with the work being done. During the discussion it developed that practically every one present was in favor of adopting the recommendations of the committee on standard practice, and action was taken embodying this sentiment as the sense of the association.

THE ILLUMINOMETER.

Mr. J. C. Heninger gave an interesting talk regarding the use of the "illuminometer" in railway work. His talk was illustrated by sketches and a machine was demonstrated to show the principles and practice of its workings. Mr. Heninger prefaced his remarks by stating that from the beginning of the time when commercial lighting assumed any proportions there has always been a demand for a clean-cut method of comparing the results obtained from the various methods of illumination. This was started away back in the days of gas and oil lighting, but has increased in importance as the use of electricity has increased.

There has always been a demand for an instrument for use by the average man, and many kinds of instruments have been devised to meet this demand. One of the earliest methods of comparing the value of two lights was by means of a scale set up like an indicator. The common form of photometer was then described, together with some of the numerous variations, and several of the latest devices of different construction were sketched out. The main point emphasized was that the simplest and most accurate and easily understood system for the practical man is the one based upon the straight law of distances.

Mr. Heninger then stated that the Sharp-Millar portable photometer had been found best adapted to that kind of work. He stated that the Blondell and Weber instruments are more accurate, but that they are not so compact or easily operated and that there are many difficulties which might arise in their use.

He then described the Sharp-Millar instrument in detail,

making sketches on the blackboard and demonstrating its uses. He showed how to determine the candle-power of lamps of various intensities and how to determine the illumination of rooms and shops at different points.

During the discussion on this paper Mr. Heninger emphasized the importance of having the voltage on the standard lamp used inside the illuminometer at the correct value, because a slight error would be multiplied many times in the process followed in making measurements. He demonstrated this by an experiment, referring particularly to the effect of change of resistance in the rheostat as it heats in service. In response to a question regarding the effect of different colored finish in cars upon the working of the instrument, Mr. Heninger stated that it is well known that there is a difference. He then showed how it could be compensated for by the use of specially prepared screens, and stated that carbon standards should be used when testing carbon lamps, tungsten standards for tungsten lamps, etc.

DATA AND INFORMATION.

The report of the committee on data and information was presented by the chairman, Mr. D. J. Cartwright, of the Lehigh Valley. The chairman stated that, owing to the confused conditions relating to car lighting, it was impossible to furnish much detailed data as to the number of electrically lighted cars in service or as to the kinds so fitted. Roughly speaking, however, there are about 5000 electrically lighted cars in service or contracted for at this date, and a list showing the numbers and equipment of those on twenty-six of the leading railroads was presented. This list covered a total of 3629 cars equipped as follows: 2316 with axle-lighting outfits (1800 of them being for 32 volts and 516 for 64 volts) and 1268 equipped with straight storage systems at 64 volts. The balance are presumably equipped with head-end systems.

The committee suggested that a printed data blank be sent to every road asking for information on electrically lighted cars, and the report includes a suggested form for such data sheet. Regarding methods for improving the service, the committee expressed the belief that if the officials of the railroads would listen to the suggestions of the electrical engineers and allow them to be tested a great amount of good would be accomplished by the association. The committee also referred to the great amount of good which should result from the exhibits being complete, and expressed the desire that more of the manufacturers might be represented next year.

CAR VENTILATION.

A paper on "Car Ventilation" was read by Mr. B. A. Stowe, of the Jandus Electric Company, and was followed by considerable discussion. A committee consisting of Messrs. Cutting, Hutchinson, Frost, Collett, Stowe and Morrison was appointed to report further on the subject at next year's convention. After some routine business was discussed the association adjourned for the day.

ELECTRICAL OPERATION OF DRAWBRIDGES.

During Thursday morning's session Mr. S. F. Nichols, of Chicago, presented a paper on the electrical operation of drawbridges. Prior to the introduction of the bascule spans in 1894, he said, the center-pier swing span was the commonly accepted type of drawbridge. These bridges were usually operated by steam. Maintaining steam day and night and getting coal and water to such plants make their operation unnecessarily expensive, especially where the traffic is light. Subsequently gasoline engines were extensively tried. Such engines are frequently difficult to start in cold weather and require considerable time for such starting, so that the engine must be kept running all the time in order to be prepared for the approach of a vessel. The series-wound reversible electric motor when developed placed at the bridge engineer's disposal an almost ideal equipment for this purpose. The first installations of electric motors for bridge operation were on highway-bridges, commencing about 1890. Such bridges were more accessible to electric energy supply than steam-railway bridges, as they frequently were bridged by electric railways.

An added incentive to the adoption of electric motors for bridge operation was furnished by the development of the bascule type of drawbridge, requiring motors on each leaf. Being very compact, the electric motor can be located very close to the point where the power must be used, obviating the necessity of having a large engine-room with a heavy floor system above the deck of either the swing or bascule span. This fact makes it possible to locate the bridge operator at the most convenient position from the standpoint of accessibility, or where the best view can be obtained of the river or railroad traffic. The motors can be located on a moving portion of the structure, while the operator's house is located on the fixed part. This is one reason why the electric motor has been so important a feature in the development of the bascule bridge. The modern bascule bridge requires the use of one or two motors for the operation of the moving leaf, a motor for the front lock and in some cases a motor for the rail lock. Frequently moving-rail locks are omitted and the end locks are operated by hand-power. Each of these motors is ordinarily provided with a solenoid brake and the motors operating the end lock and rail lock are automatically stopped by the current being cut off and the brake being applied when the lock reaches the end of its travel in either direction. The current is ordinarily cut off from the leaf motors and the brake applied when the leaf in opening reaches a point beyond which it is dangerous to allow it to travel. It is not usually feasible to install a mechanical brake, because all the motors are on the moving leaf. To provide against a failure of the motor brakes an emergency brake is usually installed which will be applied automatically in case the current fails, or it may be applied by the operator if desired. An electric solenoid has frequently been used for the purpose of releasing this brake in the past, but a better method has been found in the shape of a small electric motor operating a brake-releasing mechanism and holding it in release as long as the current is held on the motor. Rupturing the circuit by the operator or by interruption of service on the line automatically trips a release and insures instantaneous application of the brake without waiting for the mechanism to go through the reverse motion corresponding to that in releasing. This equipment is less likely to be deranged than a large solenoid, and is simpler to replace in case of trouble.

On a large swing bridge, in addition to the motors required at the center for swnging the span, a motor is necessary at each end for the rail-lock mechanism. To prevent disastrous mistakes by the usual low-price bridge operator an interlocking system has been worked out whereby it is impossible for the operator to start opening the bridge until all railroad signals have been set against the train, and no signals can be cleared until the bridge is restored and the rail locks and wedges are in place. The operations must be performed one at a time and one operation must be completed before another is begun.

The adoption of electric motors for drawbridges has usually been contingent upon being able to secure electric energy, either direct current or three-phase alternating current at 25 cycles or 60 cycles. Recent improvements in gasoline-engine design make it possible to operate to a good degree of economy comparatively small isolated electric generating plants for bridge operation. One plan is to have a generating plant large enough to supply energy directly to the motors on the bridge. This means a large generating plant. Another plan is to install a storage battery of high enough discharge rate to take care of the operation of the bridge under the severest conditions. The gasoline-generating unit in this case may be very small, simply being large enough to recharge the storage battery at the desired interval. A combination of the two plans is better yet. The paper then described the swing-bridge installation over the St. Louis River, near Duluth, Minn.

In discussion of this paper Mr. Edward Wray inquired whether any bridges are being operated from storage batteries receiving energy through mercury-vapor rectifier sets from alternating-current supply. Mr. Nichols replied that there is such an installation over the ship canal at Indiana Harbor.

CHANGES IN TRAIN-LIGHTING PRACTICE.

The Thursday afternoon session was opened with the report of the committee on train-lighting practice. This committee consisted of Messrs. George Griswold, J. R. Sloan, A. W. Chambers, George W. Murray and A. J. Farrelly, chairman. The report was to cover changes in methods of train lighting during the year. One of the most important changes in lighting from the head-end noted is that made on the Chicago, Milwaukee & St. Paul Railway, where a 110-volt system with generator at the head end has been changed to operate at 64 volts in accordance with the recommendations of the association made a year ago. This change has not involved the purchase of any new generator equipment. The steam turbine speed is maintained at 3600 r.p.m., as formerly. Extra resistance in the field circuit of the generator cuts down the generator voltage. The generators are compound-wound and part of the series-field current is shunted through a German-silver bar about 12 in. in length. The wattage of the first train equipped in this way was 7700 as against 16,700 formerly with older types of lamps. Along with this change was that of reducing the number of cells required in each set of batteries from fifty-four to thirty-two. The train lamps receive energy from a return loop, which forms the third train wire and maintains equal potential at all parts of the train. The batteries are supplied with energy from the mains before the loop is reached and hence receive a slightly higher voltage than the lamps. Curves were given of the actual performance of batteries and generators on the pioneer limited train of this company.

Another change in head-end methods during the year has been the installation on the Burlington road of an 18-volt auxiliary lighting circuit for service when the generator is not operated. Energy for this auxiliary circuit is furnished by a 9-cell storage battery on each car. It is charged from the train line 110-volt circuit.

As to axle-lighting practice, the committee recommended that in the application of axle-lighting equipment the truck be run out from under the car. Some roads refuse to do this and as a result the cost of placing these equipments is higher than if the trucks were taken from under the cars. The cost of application was given at $6.25 in one case and $4.55 in the other case.

As the number of axle equipments increases it becomes necessary to have some method of keeping track of the details of the equipment on each car. A card used by the Canadian Pacific for keeping such record was shown. In connection with this an identification plate should be used on each car axle.

In battery practice the battery connector problem has been very troublesome because of difficulties with open connection from the failure of both bolt connections and soldered joints. The failures of soldered joints have been due mostly to the corrosion of the tin in the solder by the acid. A number of roads have adopted the practice of burning across the tops of their lead bolt connectors. The committee recommends the use of the amp-hour meter on all battery equipment to determine the amount of charge and discharge the batteries have received.

ILLUMINATION.

An informal talk on illumination was given by Mr. J. R. Cravath, of Chicago. He took up first the question of measured efficiency in interior lighting. Measured efficiency he defined as being the ratio between the lumens generated by the lamps and the lumens delivered on a certain working plane. He showed how to calculate the number of lumens delivered by the lamps and showed the derivation of the unit, lumen, from the units of candle-power, distance and area. A high measured efficiency, he said, would be obtained by keeping the absorption low. To keep the absorption low the light must not be directed so as to be reflected back and forth many times between dark walls or ceilings, but must be directed with as few reflections as possible from the sources of light to the working plane. He said that by actual test it had been found that the difference between efficient and inefficient utilization in a small room might mean a difference of 4.5 to 1. Efficient utilization, of course, involves the use of light-colored ceilings and walls.

There are, however, a number of things which modify the measured efficiency before giving the practical efficiency. Artificial lighting is for the purpose of enabling one to see clearly and easily. The effect of different combinations of light on the eye must, therefore, be considered. One of the main things which interferes with seeing clearly is glare. Glare may be from the lamps themselves or it may be by reflection from paper, polished steel, etc. Glare from lamps has two detrimental effects, namely, contraction of the pupil of the eye and an automatic distraction of the attention of the eye from the object looked at to the bright light. This results in more or less effort to see clearly when lamps are in the field of vision. The nearer the lamps are to the line of sight, the worse the effect. The remedy for glare is increased area of light sources, which may be obtained by the use of large globes or reflectors, by diffusing the light through artificial "skylights" or by diffusing it from a light-colored ceiling by reflection from concealed lamps, as in the indirect system. Contrast is an element in illumination which both helps and hinders. For example, in a dark room a dimly lighted page may appear fairly well lighted. On the other hand, in a room with dark walls with many bright lamps the contrast between the dark walls and the bright lamps will always be uncomfortable and there is no way to avoid this as long as the lamps are exposed within the field of vision.

The lighting of railway cars in the past has violated all of the principles set forth. Many of these cars are finished in rather dark woodwork. The lamps are bare, thus not only wasting a large amount of the light flux on dark walls high in the car, but also presenting an amount of glare to the eyes of the passengers which really reduces their ability to read comfortably even with the insufficient illumination which reaches the reading page after excessive absorption by dark walls. For the efficient lighting of cars and for the comfort of the passengers, he recommended the use of lighter colored wood and light ceilings. These add to the cheerfulness of the car, as well as the efficiency and comfort of the lighting. Even in the use of reflectors considerable judgment must be exercised because the use of a wide distributing reflector along the sides of a day coach on lamps over each row of seats would result in excessive loss by absorption on the sides of the cars.

In all systems the human element must be reckoned with and unless the system installed be maintained in good condition the fine designs are of no avail. Fifty per cent of the light generated may easily be absorbed by dirt on the lamps and glassware. Of the glassware commonly used in car lighting, prismatic glass shows dirt the least, but is most difficult to clean. Opal glass shows dirt the soonest, but is very easily cleaned. Whatever system of lighting is in use, a proper system of cleaning and maintenance must be adopted along with it if the results are to be good.

Mr. D. J. Cartwright asked whether an arrangement of lamps in a line along the center of a day coach would be as good as a row over each seat. The speaker replied that if the lamps were placed at the same interval in both cases and the proper reflectors were used one arrangement would be as good as the other, but the appearance of lamps at sufficiently frequent intervals along the middle of the car would probably be objectionable to some of the officials of the company. One member said that the traffic and advertising department usually wants a lot of brilliant lamps exposed in a car for advertising purposes to make a fine showing when the car is standing in the station. The speaker and Mr. C. R. Gilman both took the position that the car should be lighted first for the comfort of the passengers and after that to get as much advertising effect as possible. The standard arrangement of exposed berth lamps in Pullman coaches the speaker condemned as being uncomfortable and unsatisfactory. The bull's-eye berth lamps recently developed are much more satisfactory.

CLOSING BUSINESS.

On Friday morning Mr. W. R. Bliss, of the United States Light & Heating Company, of Milwaukee, Wis., who had been

absent at previous sessions, being in attendance, was called on for a few remarks in recognition of his important work in railway-car lighting and in the formation of the association. Mr. Bliss responded fittingly to the effect that he hoped soon to see the Association of Railway Electrical Engineers take rank with the other large associations of steam-railway men, like the Master Car Builders and Master Mechanics.

An amendment was proposed to the constitution permitting the secretary to be other than an active senior member of the association. After considerable discussion the proposed amendment was lost. An invitation was received from the Washington Terminal Company for the association to hold its next semi-annual convention in the rooms of the Washington Terminal Station. It was voted to hold the next annual meeting at Chicago, the date to be left to the executive committee, but to be as near to the second week in November as posssible. It was voted to hold the semi-annual meeting in Washington, if possible, just before the Master Car Builders' convention, thus accepting the invitation of the Washington Terminal Company. The auditing committee then presented its report. Secretary Colegrove called attention to the deficit in the association's affairs and there was some discussion on the question of increasing the dues. This was finally referred to the executive committee to act if it found it advisable and to submit an amendment at the next annual meeting.

THE NEW OFFICERS.

Officers were elected in accordance with the rules of the association, which provide for balloting for each office one by one without any nomination. The election resulted as follows: President, Mr. J. R. Sloan, electrical engineer of the Pennsylvania Railroad Company, situated at Altoona, Pa.; first vice-president, Mr. F. R. Frost, electrical engineer of the Santa Fé Railway; second vice-president, Mr. D. J. Cartwright, electrical engineer of the Lehigh Valley Railway; secretary and treasurer, Mr. J. Andrucetti assistant electrical engineer, Chicago & Northwestern Railway; new members executive committee, Messrs. F. E. Hutchinson, chief electrician, Rock Island lines; C. J. Causland, chief electrician, Pennsylvania Railroad; Alex McGary, chief electrician, New York Central & Hudson River Railroad.

ENTERTAINMENT FEATURES.

A number of ladies attended the convention and various entertainment features were arranged for their benefit. There was an informal reception and dance at the Hotel La Salle on the night of Monday, Sept. 26. An automobile tour was given on Tuesday afternoon, and that evening was ladies' night for viewing exhibits, Edison moving pictures being a specially attractive feature. There was a theater matinee on Wednesday afternoon, and in the evening the Tel-Electric Company gave a musicale in the Red Room of the hotel. The annual banquet was held on Thursday evening at the Hotel La Salle. Mr. Charles E. Brown, of the Central Electric Company, Chicago, was toastmaster, and there were speeches by Mr. Warren J. Lynch, passenger traffic manager of the New York Central Lines; Mr. William H. Bennet superintendent of telegraph of the Chicago & Northwestern Railway, and Mr. H. J. Slifer, general manager of the Chicago & Great Western Railroad. The attendance was about 350. Dancing followed the banquet.

Indiana Commission News.

The report of the Indiana Railroad Commission on the recent Union City, the Kingsland and the Tipton wrecks will soon be completed, but will not be made public until after Governor Marshall has examined it carefully. It is believed that the Governor will ask the next Legislature to pass a law giving power to the commission to enforce an order requiring the installation of block signal systems on the railways.

Mr. D. E. Matthews has been appointed chief inspector for the commission, succeeding Mr. Alexander Shane, who resigned to become manager of the Indianapolis, Columbus & Southern Traction Company.

Canadian Hydroelectric Commission News.

It has been definitely announced that the official turning on of the Niagara energy will be performed by the Premier of Ontario, Sir James Whitney, at Berlin, on Tuesday, Oct. 11, at 3:30 p. m. Many invitations have been issued to the various mayors, engineers, officials, contractors and press representatives of the different municipalities connected with the transmission of Niagara energy to the Western Ontario municipalities. Mr. Thomas A. Edison has also been invited. It is planned to have a very elaborate ceremony, concluding with a banquet in the evening.

The commission at a meeting on Sept. 27 decided upon further development of the scope of the commission's undertakings. Application is being made to the interests which control the energy production in the Trent Valley for delivering energy to Cobourg, Whitby and other towns in the Midland district. With this extension the work of the commission will cover the whole Province of Ontario, namely, the Ottawa Valley, St. Lawrence frontier, Midland district, Niagara zone, Fort William and Port Arthur.

The following towns in the eastern part of the Province have requested the commission for estimates on electric service: Kingston desires 2500 hp; Belleville, 3200 hp; Deseronto, 300 hp; Brockville, between 500 hp and 1000 hp; Oshawa, 500 hp; Cobourg, 900 hp; Bowmanville, 600 hp; Picton, 500 hp, and Durham, 2000 hp.

The Toronto Electric Light Company has obtained an injunction restraining the Toronto city corporation from putting up any more poles for its hydroelectric system, or from stringing wires on those already erected. The corporation following the issuance of the injunction obtained an order for a speedy trial on Oct. 3. Mr. Kenneth L. Aitken, engineer in charge of the electrical department, has been granted a two months' leave of absence on account of illness. Mr. Alex. Dow, of Detroit, was in Toronto during the last week in September, and it was expected that he would be placed in charge of the city's work during Mr. Aitken's absence.

New York Commission News.

The Public Service Commission of the First District of New York held a public hearing last week upon the recent proposal of the Interborough Rapid Transit Company for third-tracking and extending its elevated lines. Various civic organizations of the Borough of the Bronx were in attendance, and very little objection was made to the Interborough's plans. In the offer now pending the Interborough expressed its willingness to accept a franchise on its elevated extensions running twenty-five years, with three extensions of twenty years each. For this franchise it will pay 2 per cent of the gross increase in receipts at the express stations and will submit to a readjustment of the payment at the end of each franchise period.

The commission last week issued an official booklet describing the proposed Tri-Borough Rapid Transit Railroad, bids for the construction of which will be opened Oct. 20 and Oct. 27. The system will have a total length of 44.2 miles, and under the plans the tunnel will be made large enough to accommodate a full-size railroad car. The line has been planned to carry 1,000,000 passengers a day, and the stations will accommodate ten-car express and eight-car local trains. Concrete partitions will be constructed between the tracks, so that each single track will be practically a tunnel by itself, and it is claimed that the piston action of the trains will create very much better ventilation than in the present subway.

In the inquiry into the rate charged for electricity by the Queens Borough Gas & Electric Company in the Far Rockaway section of Queens Borough, which was set for Sept. 27, a postponement was taken until Oct. 10. The company claims that by this time it will have collected all the data necessary to establish what would be a fair and reasonable rate.

The New York Public Service Commission, Second District.

gave a hearing on Oct. 4, at Albany, on the application of the Oswego Power Transmission Company for permission to begin construction and exercise right and privileges granted it by the City of Fulton, and on the application of the Peekskill Lighting & Railroad Company for permission to begin construction and exercise franchises for furnishing electricity to the Town of Yorktown, Westchester County.

The commission has received an application from the Postal Telegraph-Cable Company for an order restraining the Western Union Telegraph Company from discriminating against competitors in the matter of rates. Complainant alleges that in places in the State of New York where there is no office of the Postal Telegraph Company it is obliged to hand its messages over to the Western Union Telegraph Company for delivery. The Postal Telegraph Company collects from the sender the same fee as is charged by the Western Union between the sending and receiving points, and delivers it to the Western Union at the office nearest to the receiving point. The Western Union Telegraph Company not only charges the local fee from the point it receives the message to destination, but also adds a charge for four or five words indicating that the message had been turned over to the Western Union for further transmission, the additional words giving the place where and the date when the message was actually turned over to the Western Union. The commission is asked to make an order permanently restraining the Western Union Telegraph Company from charging any sum or sums of money on account of the adding of the additional words referred to in the complaint.

The commission has received the first complaint under the amendment of the Public Service Commissions law made last year which provides that gas or electrical corporations can make complaints as well as municipal authorities or individuals, the Buffalo Gas Company having filed a complaint against the City of Buffalo, alleging that the city is indebted to it for gas supplied in a sum upward of $124,000, which amount the city has refused to pay.

New Jersey Commission News.

The New Jersey Board of Public Utility Commissoners has approved of the proposed issuance, sale and delivery by the New Jersey & Hudson River Railway & Ferry Company of $100,000 of 4 per cent mortgage bonds. The proceeds from the sale of these bonds are to be used for the extension and construction of tracks and additions to the generating plant. The board has also approved an ordinance adopted by the Newark Board of Street and Water Commissioners granting permission to the Public Service Railway Company to construct and operate street-railway connections between its tracks in Bridge Street, Front Street and Ogden Street, Newark, it being found that the permission sought is necessary and proper for the public convenience. The application of the Hoboken Manufacturers' Railroad Company for permission to cross some fifteen streets in the City of Hoboken at grade has been denied. The ruling of the board states: "Should the local authorities approve, in whole or in part, of the application before them, the application to this board may be revived on notice to the municipality and the present disposition will not act in prejudice thereof."

Massachusetts Commission News.

Hearings have begun by the joint board consisting of the Massachusetts Railroad and the Boston Transit Commissions upon proposed subway extensions in metropolitan Boston. Last week the joint board listened to arguments of various property owners and prominent real estate interests of the West End of Boston on behalf of a tunnel loop between Park Street, Scollay Square and the Charles River section of the West End. It was contended that the Boston terminus of the Cambridge subway should have been at Scollay Square instead of Park Street. The Boston Elevated Railway Company and the Boston Transit Commission determined upon the Park Street location after a thorough study of the traffic distribution of the city. The proposed West End subway contemplates a line under the existing Tremont Street subway and a loop to the West Boston bridge. At this writing there appears little prospect that the proposition will be accepted.

The Selectmen of Abington have petitioned the Massachusetts Railroad Commission to change the fares on the Brockton and Abington line of the Old Colony Street Railway Company. A hearing will be given by the board.

Plans have been filed with the Railroad Commission by the Boston Elevated Railway Company under the signature of President William A. Bancroft for an elevated railway station on the company's Forest Hills extension. The station was recommended by the board last May as a result of a petition of residents of the Jamaica Plain district of Boston, and will be built at the intersection of Washington and Green Streets. It will accommodate trains of eight cars.

A petition has been received by the Railroad Commission for an investigation of the service on the surface lines of the Boston Elevated Railway Company between South Boston, Fields and Upham's Corners. A hearing has been assigned for Oct. 17.

The United Electric Light Company, of Springfield, has petitioned the Massachusetts Gas & Electric Light Commission for authority to issue new stock to the amount of $250,000 par value to cover the cost of plant extensions.

CURRENT NEWS AND NOTES.

Wireless for Mercantile Establishment.—Plans have been completed for the erection of two steel and wooden towers 125 ft. high on the roof of the Wanamaker store at Broadway and Ninth Street, New York. The towers are to be used for a wireless telegraph station, which will communicate with a similar station connected with the Wanamaker store in Philadelphia.

Chicago Electrical Show.—The sixth annual Chicago electrical show will be held at the Coliseum Jan. 7 to 21, 1911. The management has established the policy of sharing the profits derived from the show with the exhibitors. The basis of this is that after paying the expenses of conducting the show and the administration and setting aside a small reserve fund to the Exposition Company, the remaining profits, if any, are to be divided equally between the Exposition Company and the exhibitors, the share of the latter being prorated among them in accordance with the amount of floor space paid for by each exhibitor. The show will be held, as before, under the management of the Electrical Trades Exposition Company, and Mr. Homer E. Niesz will be manager, with offices at 150 Michigan Boulevard, Chicago.

Brooklyn Edison Educational Work.—The educational work which the Edison Electric Illuminating Company of Brooklyn has been carrying on for a number of years among its employees will be continued during the 1910-1911 season along different and what is believed will be more effective and satisfactory lines. A scholarship committee has been appointed by Mr. Freeman, the general manager of the company, and this committee, in co-operation with the faculty of Pratt Institute, has fixed upon certain courses at that institution which may be attended by any Edison employee. An employee may select any one of these courses, starting with as advanced a class as his previous training will warrant, the subjects being so arranged that those entering will not have to spend time on unnecessary matter, but will be taught just what they need to know in the line of study they take up. The tuition fee is $15 a term, which may be paid in advance or in instalments. At the end of each term the company will refund the cost of tuition to each employee who has completed the term with a fair average. It is the intention of the company in this way to give everyone in the service an opportunity to receive a technical education which will enable him to advance more rapidly and increase his value to himself and the company.

Increased Street Lighting in Chicago.—The Sanitary District Drainage Board has closed a contract with the City of Chicago for providing street lamps for the entire city and taking over the transmission lines owned and operated by the city. It is said that the number of street lamps will be practically doubled.

New York Celebration in 1913.—Plans are being formulated for a celebration in New York City during 1913 to commemorate the settlement of the city by the Dutch in 1613 under Adrian Block; the delivery of the speech of Abraham Lincoln on the battlefield of Gettysburg in 1863, and the signing of the treaty of Ghent in 1814. Mr. Henry Clews is chairman of the executive committee.

Electricity for Curing Seasickness.—According to reports from Boston, Dr. Antonio Maggiorani, of Rome, has devised an electrical treatment or "hydroelectric bath" for alleviating seasickness. The treatment is similar to that employed by Dr. Maggiorani in the hospital of the Santo Spirito, Rome, being described as "baths with electric fermentation." It is claimed that the treatment "increases the vital force of the organism so that the patient offers great resistance to nervous maladies."

International Railway Fuel Association.—The third annual convention of the International Railway Fuel Association will be held in Chattanooga, Tenn., on May 15 to 18, 1911, at the Hotel Patten. This association is made up of steam-railroad men, and it studies the production, transportation and utilization of fuels for railroad purposes. Mr. W. C. Hayes, of New York (Erie Railroad), is president, and Mr. D. B. Sebastian, of Chicago (Rock Island), is secretary.

Chicago Drainage Canal Excursion.—The contract department of the Sanitary District of Chicago, which operates the Chicago Drainage Canal, entertained a party of about forty gentlemen on an excursion down the Drainage Canal to the hydroelectric plant at Lockport, Ill., on Sept. 29. A large proportion of the members of the party were possible users of electrical energy for industrial operations, and they were much interested in the hydroelectric works, as well as the electrical generating plant, the transmission line and the terminal station. Mr. N. F. Obright, contract agent of the Sanitary District, was in charge of the party.

Electrochemical Manufacture of Fertilizers.—An important application of electricity will shortly be made by the Southern Power Company which is establishing at Great Falls, S. C., a 4000-hp plant for the manufacture of commercial fertilizers by the Guye electrochemical process. Air is forced through an electric furnace, after which nitric acid is produced by combination with water, the acid being applied to limestone to give nitrate of lime, which is the chief constituent of commercial fertilizers. Much of the machinery for the Great Falls installation, which will cost about $200,000, has been manufactured abroad and installation will begin soon.

New York Meeting of A. S. M. E.—At the meeting of the American Society of Mechanical Engineers to be held in New York on Oct. 11 Mr. Frank B. Gilbreth will present a paper entitled "Fires: Effect on Building Materials and Permanent Elimination." Among those to discuss the paper are Mr. Henry B. Keasbey, of the National Fire Proofing Company; Prof. Ira H. Woolson, of the National Board of Fire Underwriters; Mr. William D. Grier, chairman of the special committee on manufacturing risks and special hazards of the National Fire Protection Association; Mr. C. A. Turner and others concerned with various phases of fireproofing building construction.

Proposed Canadian Hydroelectric Development.—City Solicitor Hunt, of Winnipeg, has been advised by Mr. Robert Shaw Oliver, Acting Secretary of War of the United States, relative to the application of the Minnesota Power & Canal Company for permission to divert the water from the Birch Lake Basin and the Winnipeg municipal generating station at Point du Bois. Mr. Oliver pointed out that under the conditions by which the permit was issued to the company, the work of construction could not be started until a hearing had been granted every one affected. A meeting for this purpose will be held and notice sent to Winnipeg in order that the municipality may be represented.

Officers of Kansas Public Utility Association.—At the annual meeting of the Kansas Gas, Water, Electric Light and Street Railway Association, Kansas City, Sept. 27 and 28, the following officers were elected: President, Mr. W. R. Murrow, Independence; first vice-president, Mr. J. H. Rathert, Junction City; second vice-president, Mr. B. F. Eyer, Manhattan; third vice-president, Mr. H. A. Walker, McPherson; secretary and treasurer, Mr. James D. Nicholson, Newton; executive committee, Messrs. A. M. Patten, L. O. Ripley and E. S. Leavenworth. It was decided by a unanimous vote that the next annual meeting be held in Independence, Kan., on Thursday and Friday, Sept. 21 and 22, 1911.

Railway Electric Supply Manufacturers' Association.—On Sept. 29, during the annual convention of the Association of Railway Electrical Engineers, in Chicago, the Railway Electric Supply Manufacturers' Association, an allied organization, held its annual meeting. Officers were elected as follows: President, Mr. A. C. Moore, Safety Car Heating & Lighting Company, Chicago; vice-president (West), Mr. George H. Porter, Western Electric Company, Chicago; vice-president (East), Mr. H. G. Thompson Edison Storage Battery Company, New York; treasurer, Mr. Edward Wray, Chicago. The new officers of the executive committee are: Mr. Godfrey H. Adkin, Electric Storage Battery Company, Chicago; Mr. R. M. Newbold, Adams & Westlake Company, Chicago; and Mr. O. B. Duncan, J. Lang Electric Company, Chicago.

Public Lectures on Engineering in New York.—The Department of Education of the City of New York has arranged for numerous courses of lectures for the year 1910-11. Among these are courses in general physics and electricity, the program for which has been announced for October, November and December, 1910. Dr. Charles E. Lucke, professor of mechanical engineering, Columbia University, will deliver eight lectures on "Power." The subject of "Physics" will be treated in eleven lectures by Mr. J. Newton Gray, of the Manual Training High School, and nine lectures will be delivered by Professor William C. Peckham, of Adelphi College. Twenty-two lectures on the "Principles and Practice of Electrical Engineering" will be delivered by Mr. W. Wallace Ker, of the Hebrew Technical Institute. "Modern Applications of Electricity" will form the subject of nine lectures of Mr. T. I. Jones, of the Edison Electric Illuminating Company, Brooklyn. Mr. J. Newton Gray will lecture five times on "Electricity." "Electricity and Magnetism" will be treated in ten lectures by Mr. Frederick W. Huntington, and there will be eleven lectures by Mr. Charles L. Harrington.

New York Electrical Show.—At the fourth annual New York Electrical Show, which will be held in Madison Square Garden from Oct. 10 to 20, a prominent feature will be the lighting of the building as a whole. The tower will be equipped with a bank of flaming-arc lamps of the long-burning type. During the exposition the Electric Vehicle Association of America will hold its convention. Arrangements for the exposition are now being completed under the general direction of Mr. George F. Parker. The general decorative scheme will be green and gold, and the exhibitors' booths will be arranged according to entirely new models. The feature of the show, however, will be the interior lighting, which will be very brilliant. New lamps are to be put in for this occasion and 100,000 electrical lamps will flood the main hall with the brightness of daylight. There will be exhibited many novelties in electric signs, which will add to the interest of the lighting features.

APPLICATION OF ELECTRICITY TO MARINE WORK.

Equipment of the Works of the John N. Robins Company, Erie Basin Dry Docks, Brooklyn, N. Y.

As the works of the John N. Robins Company comprise the largest ship-repair and dry-docking plant in the United States, it would be well, before taking up the detailed description of the substitution of electricity for steam as a motive power, to describe generally the plant and the work to be accomplished.

The Erie Basin Dry Docks are located on Erie Basin, Beard Street, foot of Dwight Street, Brooklyn, N. Y., and comprise two basin dry docks, No. 1, 512 ft. in length and taking vessels of 20-ft. draft over keel blocks, and No. 2, 620 ft. in length and taking vessels of 25-ft. draft over keel blocks at high tide. These are timber-lined basin or graving docks, originally constructed about the time of the close of the Civil War; but they have since been extensively rebuilt and enlarged. There are besides these graving docks three floating dry docks, one balance dock of 4000 tons, one sectional dock of 6000 tons and one pontoon dock of 6000 tons lifting capacity.

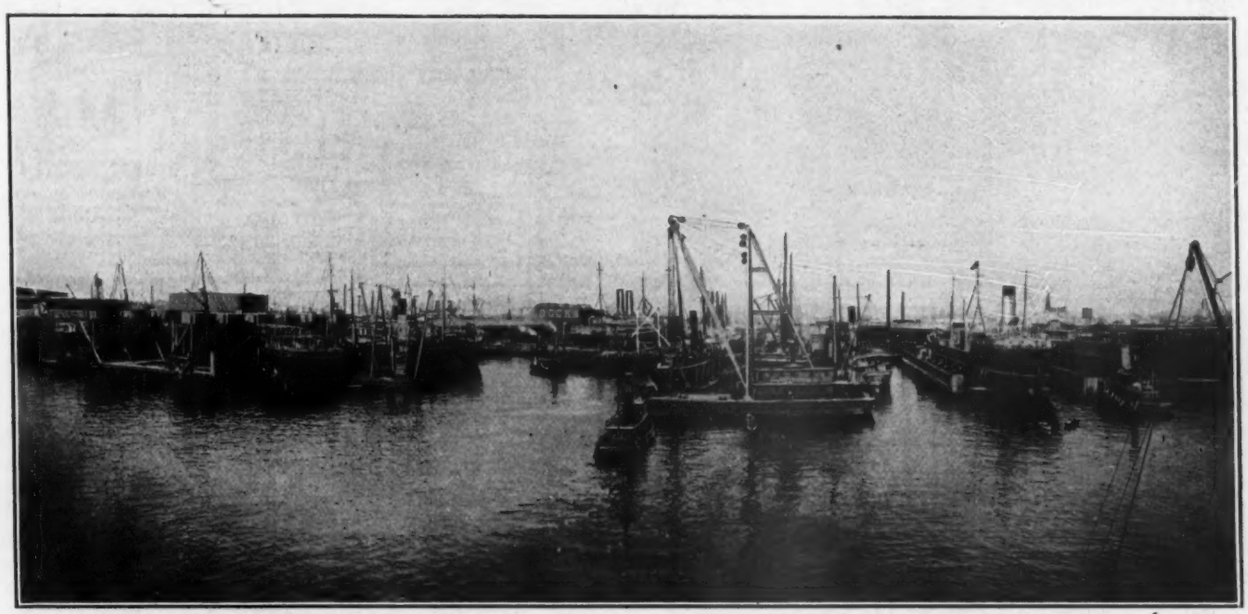


Fig. 1—General View of the John N. Robins Dry Docks on Erie Basin, Brooklyn, N. Y.

By referring to Fig. 3 the general location of the docks and the buildings will be seen. The entire plant covers an area of twenty-three acres. The shops embrace a machine shop, with tools capable of handling the largest cylinders and crankshafts; a small machine shop with small tools for general repair work; a copper and sheet metal shop; a large boiler shop with heavy rolls, punch and shears, capable of handling the heaviest plate work; a blacksmith shop with steam hammers, furnaces and plane table for forming ship ribs and other large shapes, and a carpenter shop fitted with a complete set of wood-working machinery for joiner and other wood work. The plant, as a whole, has a capacity for dry docking, painting and repairing 500 vessels a year.

Previous to the introduction of the equipment to be described energy was furnished to the machinery in this plant by nine large steam boilers, having an aggregate rating of 1700 nominal horse-power and which were operating much of the time at an excessive overload. These boilers were supplying steam at 100 lb. pressure to not less than twenty steam engines scattered over the entire works, ranging in size from a compound-engine of 600 hp, for pumping the graving docks and three steam-driven air compressors of respectively 350 hp, 130 hp and 120 hp, to various small engines rated at from 10 hp to 25 hp. With the exception of the steam plant for pumping the graving docks, all engines worked non-condensing. The aggregate nominal horse-power of the engines was approximately 2000, and as the two floating dry docks and the new one under construction would require an additional 1400 hp it will be seen that the question of supplanting steam by electricity for such a diversified and widely scattered plant was a very involved one.

REASONS FOR CHANGE.

This plant, like many others, by additions had developed without a consistent plan through a long series of years and consequently had reached a point where something radical had to be done. The steam boilers were of the horizontal tubular type and on account of the local conditions of the buildings two fire-rooms were maintained at a considerable distance apart. There were, moreover, no adequate facilities for handling or storing fuel, and it was necessary to rehandle fuel separately for each fireroom. The burning of bituminous coal under the condition of excessive intermittent demand for power resulted in smoke production, which was strongly resented by local authorities. At the same time it was quite apparent that a considerable economy should result from the proper application of electricity as compared with steam.

The first and most important question to be decided was the advisability of purchasing electricity from a central station or installing electric generating equipment. The great diversity of work to be done made this question a difficult one. The plant often works at full capacity night and day and at other times there is little work on hand. Again, the aggregate amount of energy to be used when several dry docks are operating at one time, besides a large air-compressing plant, would mean a very large installation and an exceedingly bad load factor. The suddenness with which these loads would be thrown on and off, it being understood that a floating dry dock is usually pumped in less than one hour and a basin dry dock in about two hours, would demand quick firing of boilers and a large force of firemen always on hand.

Therefore, a most careful study was made to determine the distribution and use of energy and the yearly consumption of coal, from which an operating cost was worked out as a basis for determining the maximum unit price which it would be possible to pay for electricity and still show a reasonable economy over existing conditions. With this point determined the matter was taken up with the local central station for the distribution of electrical energy, and after an extended discussion a satisfactory contract was finally arranged so as to

favor the central station as much as possible as to peak loads and the dry dock company as to having a large amount of power available at any time of day or night. The details of the form of this contract are of little general value, as it was worked out to suit very unusual conditions.

GENERAL PLAN FOR THE INTRODUCTION OF ELECTRICITY.

It will be understood from the foregoing that no general plans could be formed until the main question of central station or independent generation of electricity had been settled. The advisability of a central-station source of energy having been reached, a general review of the application of electricity and the amounts was started, and it was decided to adopt the primary voltage of the central-station system for the larger units in the yard and for distribution about the works; the dry dock company to operate its own transformers for low-voltage energy adaptable to smaller motors.

Referring to Fig. 2, which is a general diagrammatic view of the entire installation, it will be seen that service was introduced from the Edison mains of 250,000 circ. mils at 6600 volts, three-phase and 25 cycles. A main substation, located as shown on the general plan, was provided for handling all high-voltage connections. This station is located in a special structure elevated one story above the ground, so as to avoid moisture conditions as much as possible. The switchboard, as will be seen by referring to the photographic view, is composed of 13 panels, two of which are used to handle the Edison service and the others, as indicated on the diagram, for controlling distributing circuits to high-tension motors for compressing air and pumping the graving docks. Other switches control circuits to local substations with transformers for various purposes as indicated.

All switches are of the standard oil type and each panel is provided with a time-limit-relay circuit-breaker and with a watt-hour meter to furnish an independent record of the consumption of electrical energy for the different purposes to which it is applied, thus making it possible to charge up the cost of electricity for the different docks, machine shops, compressed air and other purposes for which it is used.

DISTRIBUTION OF ELECTRICITY.

The general arrangement for the distribution of electricity and the location of minor substations will be seen by reference to Fig. 3. The distribution of energy to these stations is accomplished by underground conduit and lead-covered cables. The conduits are of fiber, encased in concrete. The cables are of the same high standard and specification as those used by the Edison Electric Illuminating Company of Brooklyn, from which the electricity is obtained. Manholes are provided at suitable intervals for hauling cables and every possible precaution is taken as to drainage of the ducts and protection of the circuits from injury.

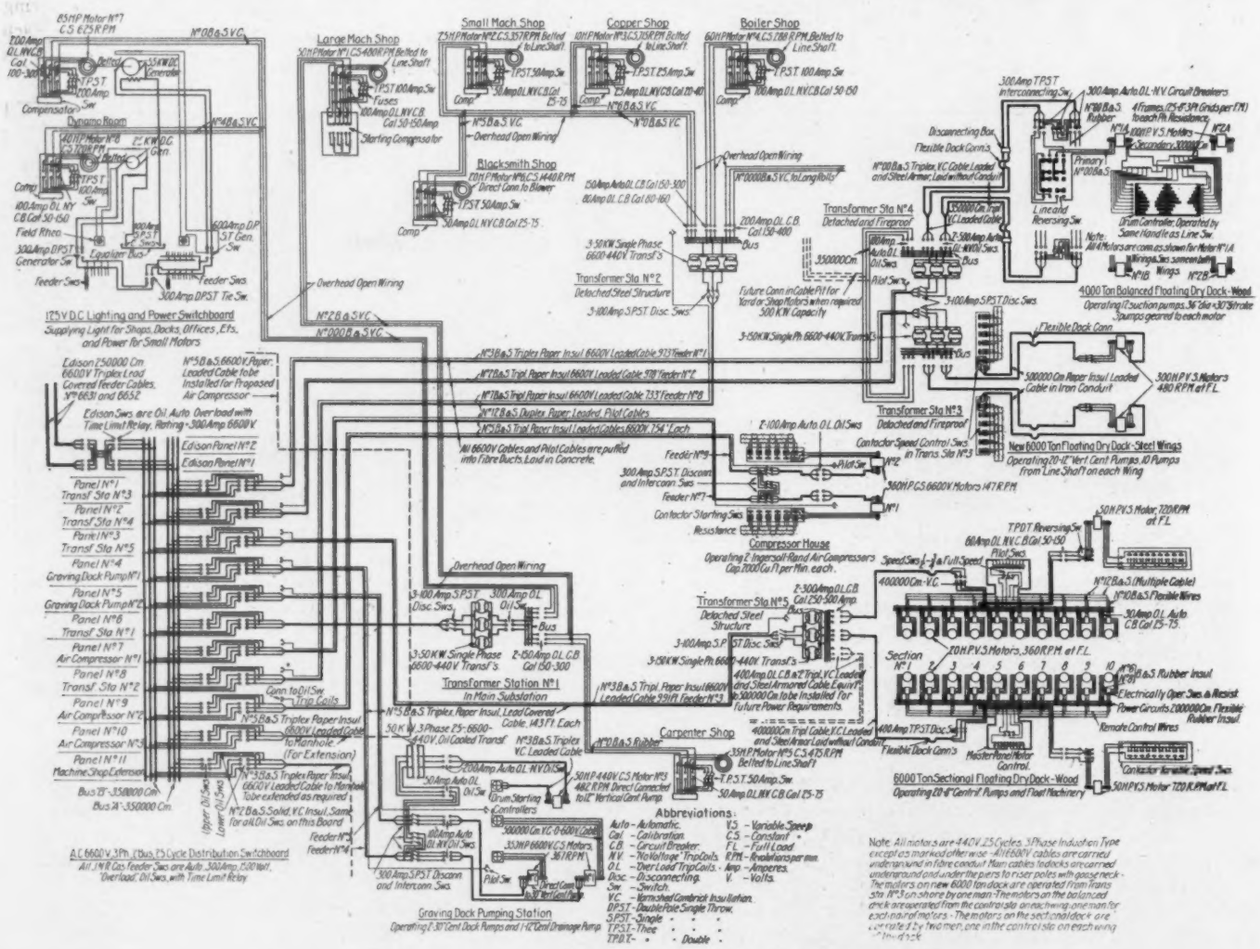

Large Mach. Shop
Small Mach. Shop
Copper Shop
Boiler Shop
Blacksmith Shop
Transformer Station N°1
In Main Substation
Transformer Sta N°2
Transformer Sta N°3
Transformer Sta N°4
Transformer Sta N°5
Compressor House
Carpenter Shop
Graving Dock Pumping Station
125 V D.C. Lighting and Power Switchboard
Supplying Light for Shops, Docks, Offices, Etc., and Power for Small Motors
A.C. 6600 V. 3 Ph. 25 Cycle Distribution Switchboard
Abbreviations.
Auto - Automatic.
Cal - Calibration.
C.B. - Circuit Breaker.
N.V. - No Voltage Trip Coils.
O.L. - Over Load Trip Coils.
Disc - Disconnecting.
Sw. - Switch.
V.C. - Varnished Cambric Insulation.
D.P.S.T. - Double Pole Single Throw.
S.P.S.T. - Single " " "
T.P.S.T. - Three " " "
T.P.D.T. - " " Double "
V.S. - Variable Speed
C.S. - Constant "
F.L. - Full Load
R.P.M. - Revolutions per min.
Amp. - Amperes.
V. - Volts.
Overhead Open Wiring
Future Conn. in Cable Pit for Yard or Shop Motors when required 500 K.W. Capacity
Flexible Dock Conn.
New 6000 Ton Floating Dry Dock - Steel Wings
Operating 20-11" Vert. Cent. Pumps, 10 Pumps from Line Shaft on each Wing
6000 Ton Sectional Floating Dry Dock - Wood
Operating 28-6" Centrif. Pumps and Float Machinery
4000 Ton Balanced Floating Dry Dock - Wood
Operating 17 suction pumps, 36" dia. × 30" Stroke Plungers geared to each motor
Section N°1 2 3 4 5 6 7 8 9 10
Electrically Oper. Sws. & Recist.
Power Circuits 2000000 Cm. Flexible Rubber Insul.
Remote Control Wires
Master Panel Motor Control.
Contactor Variable Speed Sws.
Power Circuits 1000000 Cm.
Lines of Reversing Sw.
Drum Controller, Operated by Same Handle as Line Sw.
Note. All 4 Motors are connected as shown for Motor N°1. A Wiring & Sws. same as both Wings.
Note. All motors are 440 V. 25 Cycles, 3 Phase Induction Type except as marked otherwise - All 6600 V. cables are carried underground in fibre conduit. Main cables to docks are carried underground and under the piers to riser poles with gooseneck - The motors on new 6000 ton dock are operated from Trans. Sta. N°3, on shore by one man - The motors on the balanced dock are operated from the control station each wing, one man for each pair of motors - The motors on the sectional dock are operated by two men, one at the control station on each wing

Fig. 2—Diagrammatic View of Entire Electrical Installation.

INTRODUCTION OF ELECTRICITY.

The actual introduction of electricity into this plant centers about, and was occasioned by, the building of the new 6000-ton pontoon floating dry dock with steel wings, and the description of its introduction will, therefore, more or less center about the putting into operation of this dock, it being understood that all changes were to be made without interrupting or in any way interfering with the operation of the works.

The plans were completed and work first commenced upon the main substation; then followed installation of the conduit and cables for distribution to and the construction of the minor substations. All of this work was practically completed by the time the floating dry dock referred to was delivered at the

yard, and the first application of electricity was to the pumps of this dock, about Feb. 1, 1909.

6000-TON PONTOON FLOATING DRY DOCK.

The pontoon floating dock has a length in the wings of 335 ft., a width over all of 100 ft. and a depth of pontoon of 11 ft. The maximum net lifting power is 6000 tons, raising a vessel of approximately 400 ft. in length. The lifting power

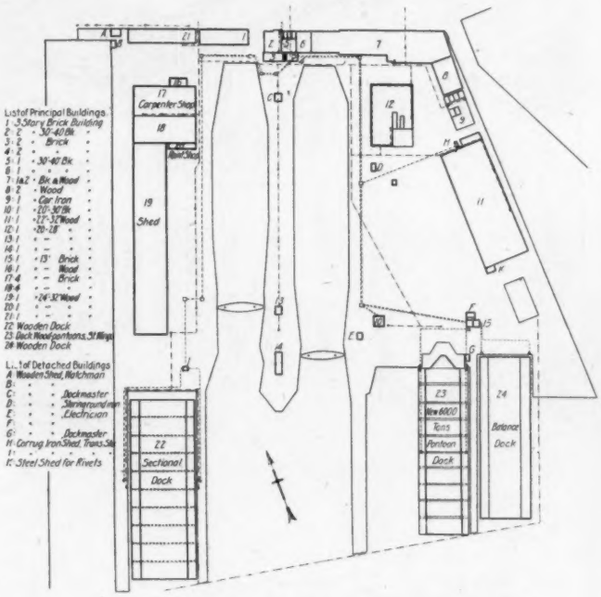


Fig. 3—Plan View of Erie Basin Dry Docks.

is the combined buoyancy of ten pontoons, all separate floating structures mechanically united together by the steel wings or side walls. The lifting power is obtained by pumping out the water which has previously been admitted to sink the dock. For removing this water there are ten 12-in. centrifugal pumps on each side of the dock. Each set of pumps is operated by a 300-hp electric motor through a horizontal line shaft, miter gearing and vertical shaft to the pumps located at the bottom

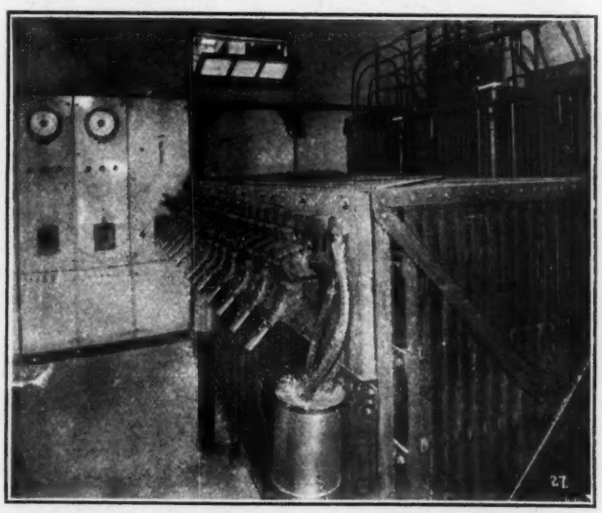


Fig. 4—Substation and Controller Room for Pontoon Dry Dock.

of each end of each pontoon. These pumps deliver the water against a maximum head of 15 ft. The electric motors operate at 485 r.p.m. and the line shaft and pumps at 250 r.p.m.

OPERATION OF 6000-TON DRY DOCK.

To sink this dock flood gates are opened to admit water directly through the pumps, and as the water continues to enter the dock settles until it has reached the necessary depth to allow the vessel to enter above the keel blocks. The flood gates are then closed until the vessel has been located and secured centrally in the dock. This is done under the direction of the dockmaster, who stands on the pier directly in front of the vessel. It will be understood that the operation of the pumping machinery by the motors is controlled from substation No. 3, located on the pier within about 20 ft. of the point where the dockmaster stands, and that as soon as the vessel is properly

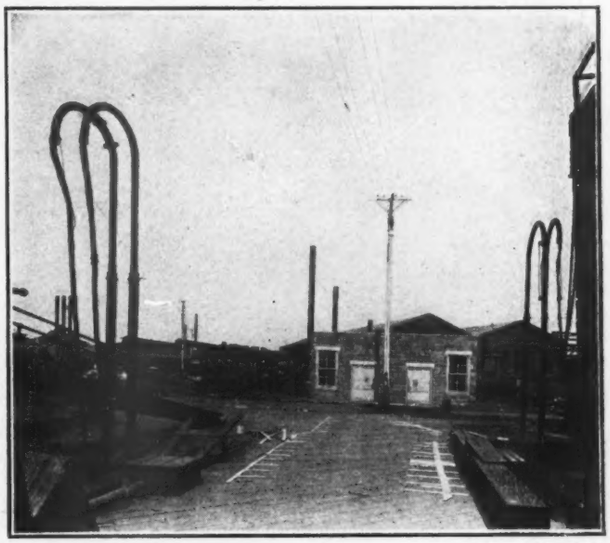


Fig. 5—Substation and Method of Carrying Conductors to Floating Dry Docks.

located the signal is given for starting the motors. The controllers for these motors are of such construction as to obtain a wide variation of speed ranging from 10 per cent up to full speed. Variation of speed is obtained by inserting resistance in the armature circuit in the usual manner by means of slip rings, it being understood that the secondary circuits from the armature are conducted from the floating dry dock through flexible connections to the pier and to the substation, a distance of approximately 200 ft. The contact levers for the controllers are of the laminated pressure type with carbon

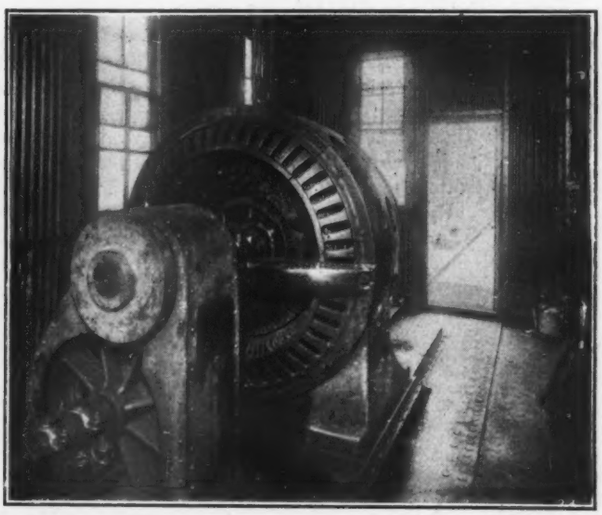


Fig. 6—300-hp. Induction Motor on Pontoon Dry Dock.

break and the main circuit is supplied with oil switches and time relay circuit-breakers. The resistance used is of the standard cast-iron grid type and of such an amount as to allow the motors to be operated continuously at any speed.

It will be seen by referring to the general plan that this substation is located in the same building as the one for the balance dock substation No. 4, and that while separate transformers are provided for each dock provision is made for the

cross connection of the transformers so that either bank may be used to operate either dock, as a provision against breakdown. The electric motors were manufactured and installed by the Western Electric Company, the controllers were manufactured by the Cutler-Hammer Manufacturing Company and the transformers by the Western Electric Company.

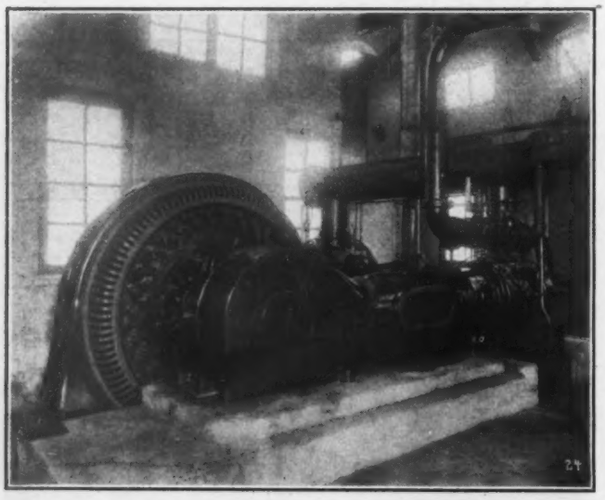


Fig. 7—Motor-Driven Air Compressor.

The full capacity of the dock can be pumped in from twenty-five to thirty-five minutes, requiring the handling of approximately 10,000 tons of water. This dock was put into commission about the first of February (midwinter), 1909, and from the first has continued to operate in a most satisfactory manner. The control of the pumping machinery on both sides of the dock by one man, located so as to be directed most readily by the dockmaster, has proven to be a very great advance over anything heretofore accomplished. When it is taken into consideration that this was the first introduction of electricity in this plant and that the operation was by workmen entirely unfamiliar with its application, the result is highly satisfactory. Those desiring a more complete description of the construction and operation of this floating dry dock are referred to the August, 1909, issue of *International Marine Engineering*.

BALANCED FLOATING DRY DOCK.

The second application of electricity was to the 4000-ton balanced floating dry dock located adjacent to the one previously described. This dock is one of the oldest floating structures in New York Harbor, having been built more than fifty years ago. The pumping of this dock was accomplished by steam engines operating through gearing six single-acting bucket pumps on each wing. These pumps were each 36 in. in diameter and 30-in. stroke, designed to operate at about twenty-two strokes per minute. As the pumps were of very ample capacity and simple construction it was not deemed necessary to change them.

The boilers and engines were removed and replaced by two 100-hp electric motors on each wing, each motor driving a group of three pumps, and as it had been customary for the dockmaster to control this dock from the deck of the vessel being raised, the controllers were placed upon the dock, the motors on each wing being under control of a separate operator who could readily be directed by the dockmaster on board the vessel. The motors operate at 450 volts, 470 r.p.m. full load and are controlled by drum controllers and resistances in the armature circuit to give variable speed.

As previously stated, the energy for these motors is supplied by transformers from transformer station No. 4. The operation of the dock with these motors has been entirely satisfactory from the beginning. Their application has resulted in the removal of a considerable fire risk and a very considerable weight of boilers, engines and fuel. The time required to pump the dock is about one and one-half hours. These motors were manufactured by the Wagner Electric Manufacturing Company and the controllers by the Westinghouse Electric & Manufacturing Company.

AIR-COMPRESSING PLANT.

The next application of electricity was to an entirely new air-compressing plant, replacing the steam-driven machines

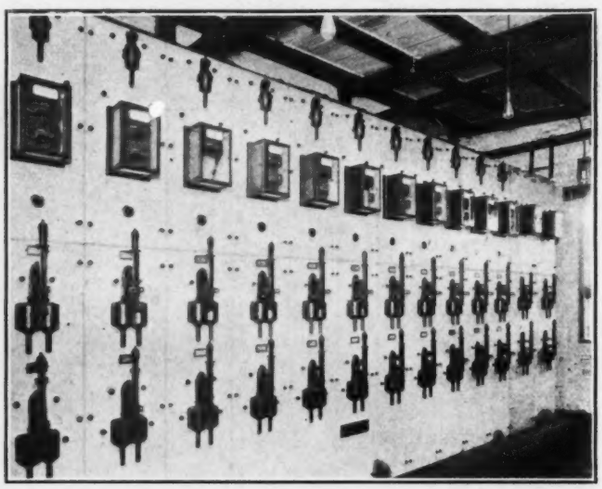


Fig. 8—High-Tension Switchboard.

previously used, which were of early design and low economy. By referring to the general plan it will be seen that the new air-compressing plant is located at a central point for the purpose of reducing air distribution losses to as small an amount as possible.

This plant, which is one of the first large compressed-air

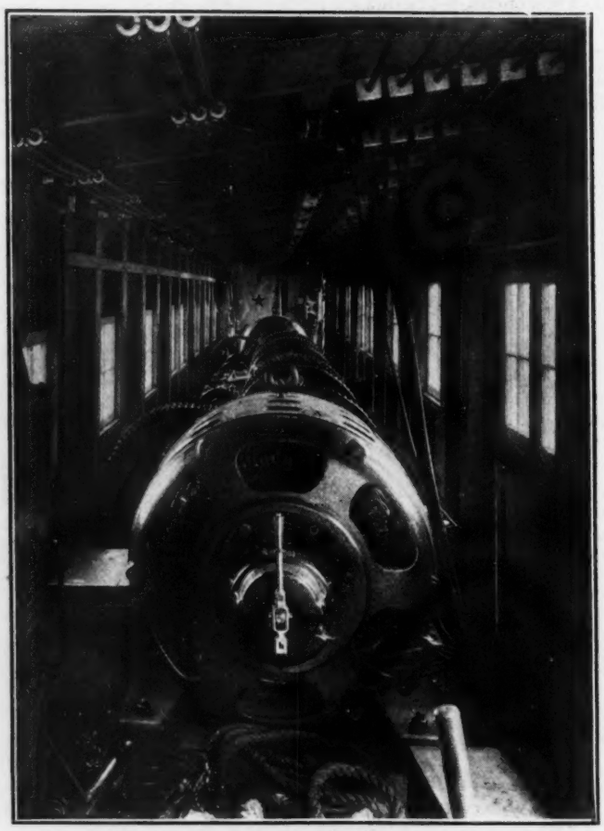


Fig. 9—Induction Motors on Balanced Dry Dock.

plants to be driven by high-tension motors, deserves careful consideration. It is composed of two units each of 2000 cu. ft. capacity per minute. These machines operate at 145 r.p.m.,

the operation being by direct-connected 6600-volt electric motors. The high-tension current is brought from the underground conduit to the switchboard provided with oil switches and overload, time relay, circuit-breaker in the second-

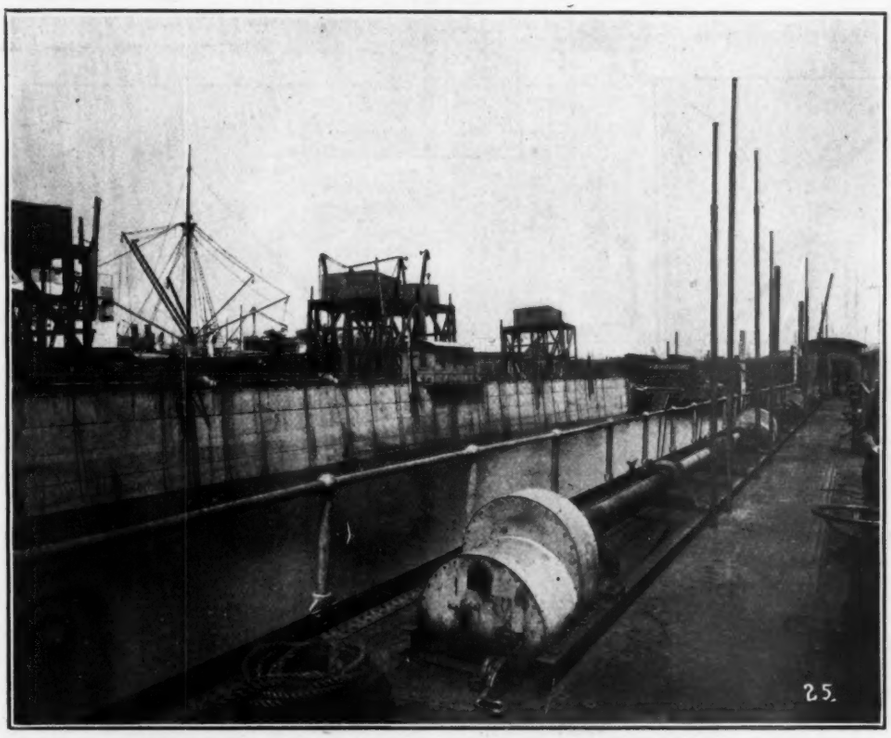


Fig. 10—6000-Ton Pontoon Floating Dry Dock Partially Submerged.

ary or armature circuit. Each unit requires 360 hp at full load. These motors and controllers were designed and installed by the Western Electric Company. The air compressors are of the well-known piston-inlet, hurricane-valve type manufactured by the Ingersoll-Rand Company. The low-pressure cylinder is 27¼ in. in diameter and the high-pressure cylinder 15¼ in. with a stroke of 24 in. To insure clean, dry air the intake was carried up through the roof, the air entering through a hooded and screened ventilator cap. An 8-in., high-pressure discharge from each machine runs independently to a receiving and cooling tank on the outside of the building. The air leaves this tank near the bottom by two 8-in. mains for distribution underground to docks and shops.

A new and ingenious method of air unloading was used for the first time on these machines. A series of small air tanks or receivers proportioned relatively to the volume of the cylinder and so connected to the delivery valve of the cylinder as to be thrown into connection therewith by automatic action of the controller increases the clearance in the cylinder and thus reduces the amount of air delivered.

From the time of starting these machines not the slightest trouble or interruption has been experienced with the electrical operation and on many occasions the machines have run from week-end to week-end without shutting down. Provision was made in the design of the machines for the use of either salt or fresh water for air cooling, and for handling the salt-water circulation a 2-in. centrifugal pump was provided, driven by a belt from the main shaft of the machine.

GRAVING DOCK PUMPING PLANT.

In dry-docking a vessel in a graving dock the ship enters an open slip and when fully entered a floating gate or caisson is placed across the entrance, thus closing it from the sea. The ship is then centered over a line of keel blocks down the middle of the basin or dock. The water is then removed from this enclosure by allowing it to flow from the other end of the dock by an underground passage or conduit to a well of a depth somewhat greater than the dock itself. From this well the water is removed by large pumping machinery.

It will be readily understood that with proper conduits or underground connections more than one graving dock may be pumped by the same machinery. In the case under consideration two docks situated side by side are served by one set of pumps located at a point which may be readily determined by referring to Fig. 3 marked "Pump House."

Reference to Fig. 13, showing a section of the well, the pumping machinery and electric motors which are to be described, will aid in the general understanding. It will be understood that the new pumping plant was to be installed without interrupting the use of the docks, which were being worked to their full capacity, often being pumped three or four times a day.

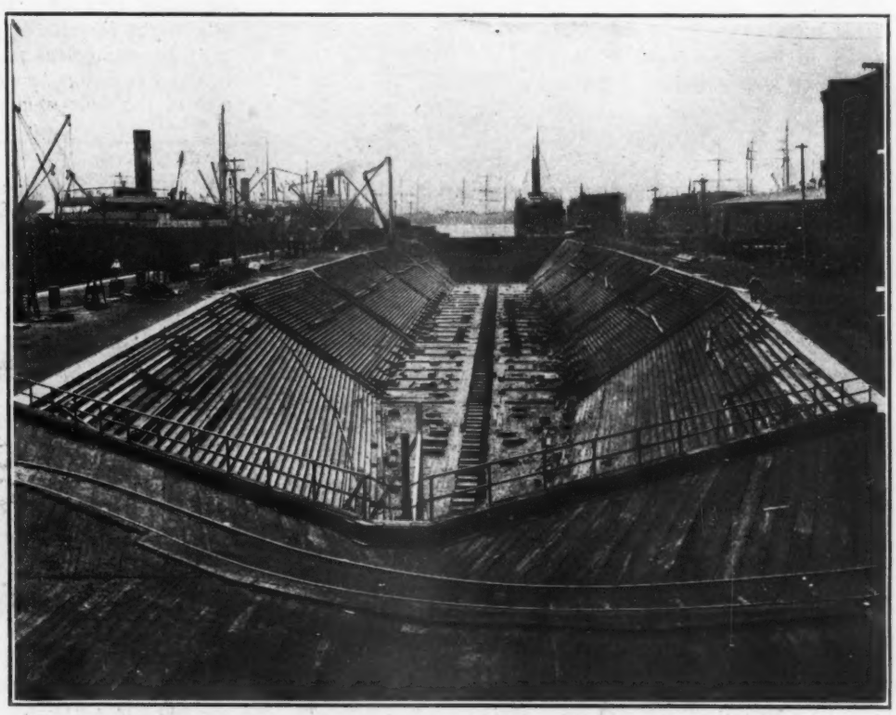


Fig. 11—Smaller Graving Dock at J. N. Robins Works.

The steam-pumping plant consisted of a compound marine engine driving, through gearing, two 30-in. centrifugal pumps, and occupied all of the building indicated as "Pump House" in Fig. 3. The new plans provided for installing the pumps in the upper part of the well, handling the valves in what had been the former valve room and placing the motors one story above ground over the valve room. To accomplish this it was

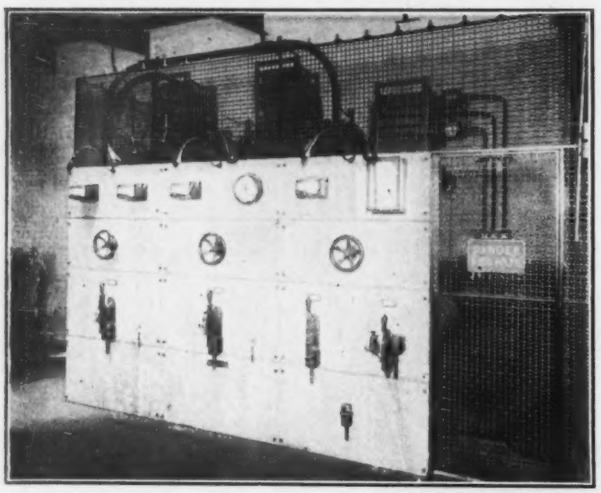


Fig. 12—Graving Dock Pumping Plant Switchboard.

necessary to make a connection to the 30-in. vertical suctions below the horizontal delivery to the old pumps. This was done in a little more than two days and was the only interruption during the entire progress of the work.

Horizontal check valves were inserted in the new connections

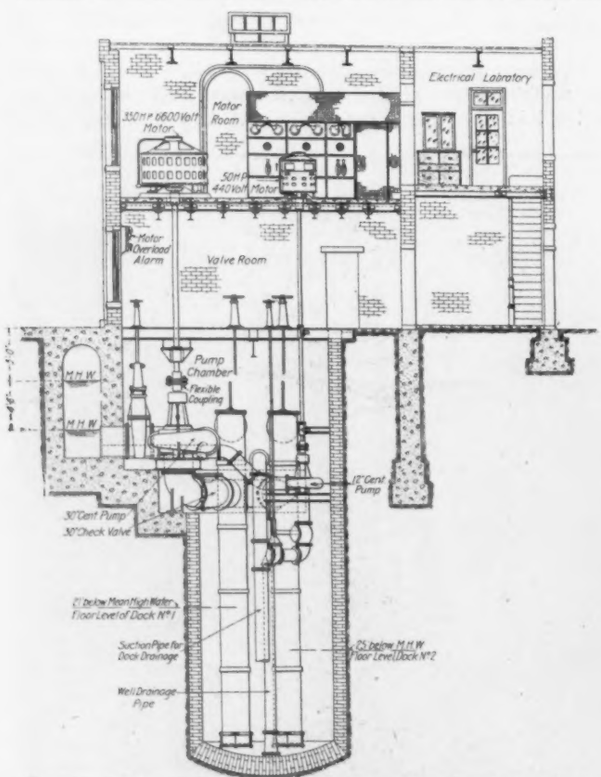


Fig. 13—Sectional Elevation of Graving Dock Pumping Plant.

and the vertical centrifugal pumps connected directly to these outlets through vertical L's, and the delivery of the pumps was carried through 30-in. gate valves and a concrete wall to the delivery conduit extending 300 ft. and delivering into the head of the slip at the northern corner of the works.

Besides the two 30-in. pumps referred to there was installed a 12-in. drainage pump with connection to both docks and also to the bottom of the well. It will be understood that basin dry docks are never entirely watertight and that a pair of these

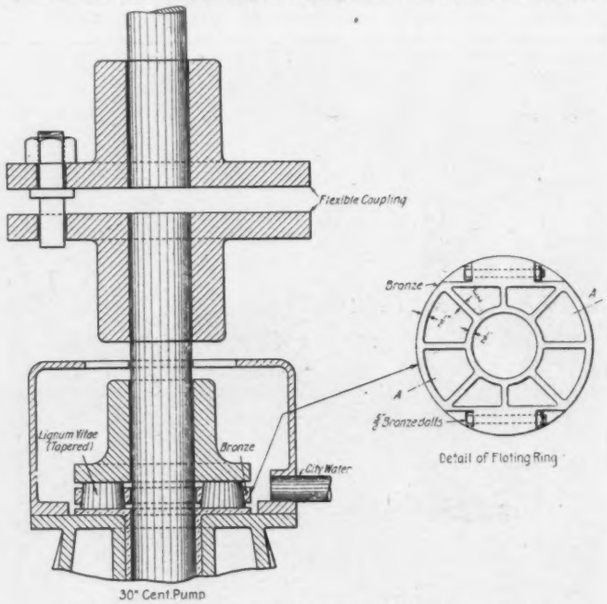


Fig. 14—Details of Floating Ring Thrust Bearing.

docks, such as are here shown, require a 12-in. centrifugal pump to be in almost constant operation.

By referring to Fig. 13 it will be seen that the pumps are installed below low water level and considerable difficulty was encountered in the installation of proper reinforced concrete foundations for such heavy machinery. The floor of the valve room is of steel I-beams overlaid with iron plates in such a manner that both plates and I-beams may be removed to a sufficient extent to handle all machinery and fittings placed in the well. This is facilitated by the heavy I-beam construction of the motor-room floor, the lower flanges of which provide a ready means for attaching hoisting tackle.

The motor-room floor is of steel and concrete construction, the two 350-hp motors being carried on two 24-in. I-beams and the rest of the floor supported by 18-in. I-beams. The walls

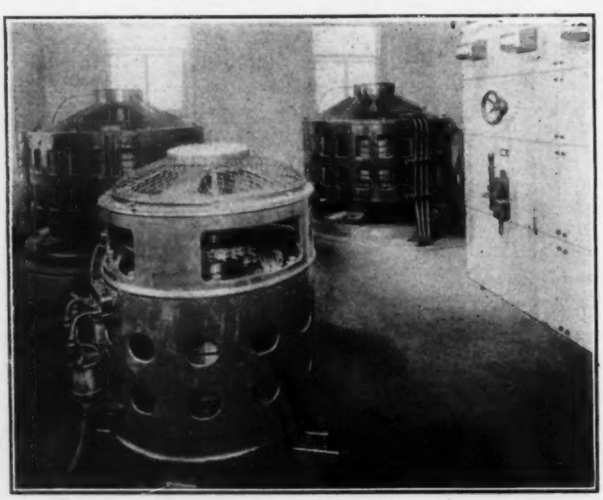


Fig. 15—Pump Room and Motors for Graving Docks.

are of hard brick 20-in. thick, laid in cement. This construction has resulted in a perfectly steady motor-room with two 350-hp motors operating at 375 r.p.m. The 50-hp drainage motor runs at 500 r.p.m. The armature and vertical shaft of these motors are carried on ball bearings at the upper end of the shaft.

Flexible couplings are introduced just above the pumps which are provided with independent water-cooled thrust bearings.

ELECTRICAL EQUIPMENT OF GRAVING DOCK PUMPS.

As previously stated, the two larger motors operate at 6600 volts and by reference to Fig. 13 the arrangement of the controllers and starting switches will be plainly seen. Oil switches are used and the multiple switch starters are provided with

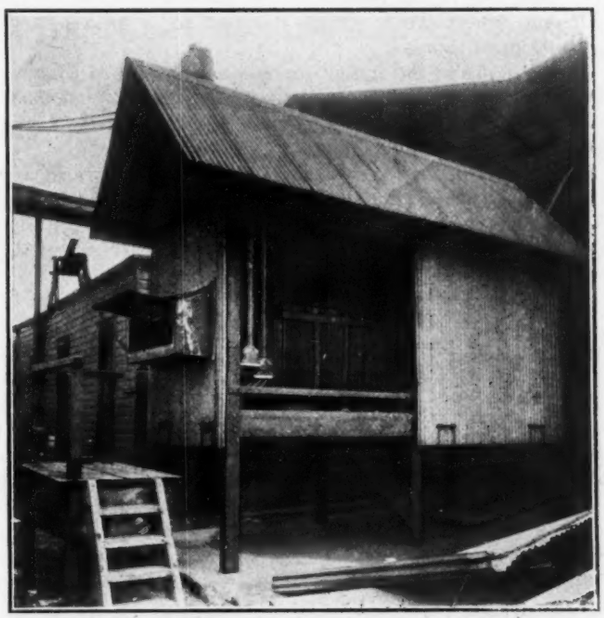


Fig. 16—Transformer Cabin and Switch Box in Yard.

resistance for starting only and so arranged, by interlocking, that the main switch cannot be closed for starting unless all the resistance is in the armature circuit; any desired control of the pump being obtained by closing the delivery gate valve from the pumps. In fact, positive instructions are given always to start up the pumps with the delivery valves closed, which has the effect of starting up with friction load only, the load then being gradually added as the delivery valve is opened.

It might further be explained that while these centrifugal pumps must deliver against a maximum head of nearly 40 ft., the pumping commences against zero head or with the level of water inside and outside of the basin the same. It should also be understood that in handling water with centrifugal pumps operated by electric motors it will be found that the pump will not overload by increase of head, but that the paradoxical or opposite result will occur; that is, the motor will unload by the increase of head and will overload by a decrease of head.

By referring to Fig. 13 there will be seen directly over the delivery valves from the pumps a motor overload alarm. This is an electric bell arranged to have its circuit closed by an overload relay and will commence ringing as soon as overload takes place. This will occur if the delivery valve is opened too wide when the pumps are first started against a zero or very low head.

The drainage pump motor is operated at 440 volts and at 500 r.p.m. Continuous oiling for all these motors is obtained by centrifugal pump action which circulates oil from a receptacle above the lower bearing through a small pipe to the thrust and upper bearing. The operation of these motors has given perfect satisfaction from the first. Some difficulty was experienced with the thrust bearings of the pumps and the fact was finally apparent that no satisfactory thrust bearing for pumps operating under similar conditions had been developed. This difficulty was met by designing a floating ring thrust bearing with lignum vitæ pins, illustrated in detail in Fig. 14. These rings are made in halves and can readily be replaced when worn. They have now been in operation on the two larger pumps for several months, giving perfect satisfaction, and in the judgment of the mechanic in charge will not require renewal for a long time. Fresh water from the city mains is used for cooling while the pumps are in operation. Approximately two hours are required to pump out the water from the larger dock, during which time there is handled approximately 7,500,000 gal. of water.

The pumps were furnished by the Morris Machine Works, of Baldwinsville, N. Y., and the electric motors and controllers by the General Electric Company.

ELECTRIC LIGHTING AND SHOP MOTORS.

Direct current is used for lighting the plant, obtained from one 55-kw and one 25-kw generator, which were formerly belt-driven from separate steam engines. By referring to Fig. 2 it will be seen that the present installation provides for the driving of these generators by motors of 85 hp and 40 hp respectively, through belt connection.

The general arrangement of switchboard and connections for lighting are shown on the diagrammatic plan referred to. The energy for driving these motors is obtained from a bank of three 50-kw, single-phase transformers reducing the potential from 6600 volts to 440 volts. These transformers also supply energy at the same voltage for the shop motors.

There are two constant-speed motors for the machine shop, the larger one, a 50-hp motor, operating at 480 r.p.m., belted to the line shaft. The smaller machine-shop motor of 25-hp operates at 357 r.p.m. This motor is attached to the ceiling and belted to line shaft.

In connection with the blacksmith shop there is a 20-hp motor operating at 1440 r.p.m. directly connected to a blower. This blower and motor are installed on a concrete foundation protected by a small frame structure conveniently located to the forges. There is a 10-hp motor operating at 715 r.p.m. driving small machinery in the coppersmith shop; also a 60-hp motor operating at 288 r.p.m. driving a line shaft in the boiler shop. These motors receive energy from a bank of three 50-kw,

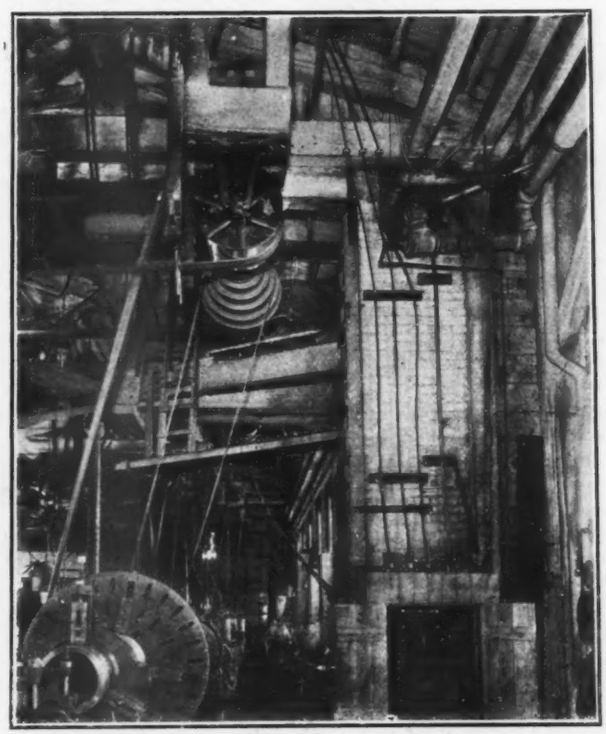


Fig. 17—Large Induction Motor in Machine Shop.

single-phase transformers located in transformer station No. 2, a detached steel structure near the boiler shop. There is a carpenter shop motor of 35 hp operating at 475 r.p.m. belted to line shaft, operated from transformers in transformer station No. 1.

In the shop operation the policy of operating line shaft with motors was adopted rather than employing individual machines. The reasons for this practice were not only the great economy in cost of installation, but the fact that in a plant of this kind much of the machinery is operated only at infrequent intervals and that most of the machinery is of early design and not particularly adapted to the direct application of electricity.

The general practice will be adopted of installing new machinery with direct-connected motors. In every case the shop motors have either been installed on the ceiling or on a special platform erected so as to be entirely out of the way. Photographic illustrations shown herewith will convey a clear understanding of the method adopted. All shop motors are of the constant-speed type, manufactured by the General Electric Company, and are operated through General Electric compensators.

6000-TON SECTIONAL DRY DOCK.

This dock is of very unusual construction and operation, being the only remaining example of a dock much in use forty years ago and then known as the Dodge-Burgess sectional floating dry dock, and would require a much more extended illustration and description than is allowable at this time for its complete understanding As the application of electricity to this structure is not completed, a more detailed description with illustrations will be given at some future date.

Generally speaking, the equipment is to consist of twenty 20-hp motors and two 50-hp motors. The 20-hp motors are each to be directly connected to a centrifugal pump and the 50-hp motors are to be connected to mechanism for controlling ballast tanks. The machinery will be operated in two sets of ten 20-hp motors and one 50-hp motor, the 50-hp motor being arranged to operate in either direction. In connection with the 20-hp motors there is a special controller system which permits of the ten motors in each group being started, stopped or operated from a master controller, and it will also be possible to operate the motors at three different speeds, it being understood that it is a requirement to operate all the motors at the same speed but to vary the speed of the whole group.

GENERAL OBSERVATIONS.

There is now installed and in operation 2774 hp of motors. The total energy consumption for the month of May, 1910, was 263,200 kw-hours and it is interesting in an installation of this kind to learn from the watt-hour meters on the main switchboard the distribution of this energy.

The list is headed by the air compressors, which have a combined consumption of 67.1 per cent of all the energy used. Transformer station No. 1 supplied energy for the lighting dynamos and machine-shop motors and shows a consumption of 9.48 per cent. The two large graving-dock motors come next with a consumption of 9.52 per cent, followed by the small graving-dock drainage motor with 7.36 per cent. Transformer station No. 2, supplying the boiler-shop, copper-shop and blacksmith-shop motors, takes 3.54 per cent of the energy. The new dock, with two 300-hp motors, consumes only 1.56 per cent and the balance dock, with four 100-hp motors, 1.44 per cent.

Attention is called to the fact that the 50-hp motor running nearly constant on the graving docks consumes almost as much energy as the two 350-hp motors used in pumping these docks. The new 6000-ton pontoon dock has a capacity almost as large as one of the graving docks and handles more vessels than either, but requires less than one-fifth of the energy to operate it.

Since the introduction of the high-tension electricity into the yard in February, 1909, the main switch supplying the high-tension service has been thrown out but once by a short-circuit caused by the closing, by mistake, of a switch on a dead-end cable which had been sealed over the end when pulled in and not protected when connected to the switchboard. This caused an interruption in the service for about one hour.

While there is a total installation of 2774 hp, it has been found practicable to work with a maximum demand of 1200 kw, a figure which was arrived at at the time the contract for service was arranged, it being understood, of course, that maximum demand influences the cost of energy. It is practically certain that if the works were operating from a private electric generating plant the installation would have to be very much greater, in all probability not less than 2500 kw, to allow for spare boilers and generators and the unwillingness of the different departments to handle the work so as to keep down the maximum load.

By the terms of the present contract any amount of power is available to meet a necessity, but it is distinctly understood that a study of the distribution of the work will mean a saving and directly affect the earnings of the company.

A daily record of the watt-hour meter readings is kept and checked with the monthly bills from the central-station meters. The positive knowledge of the cost of energy and its distribution is of very great value to the accounting department of the business.

The elimination of coal handling and of the maintenance of steam boilers and furnaces has greatly simplified the operation of the plant. An unlimited amount of power available at any hour of day or night by simply closing a switch is an advantage which cannot be overestimated.

Fig. 18—Motor in Boiler Shop.

It should be understood that in ship-repair work the utmost dispatch and promptness in executing work is the first consideration. In the month of October, 1909, the steamer *Howard* was put into graving dry dock No. 1, cut in two, the bow drawn forward 40 ft., this space built in with ribs, plating and all interior work, made watertight and left the dry dock in fourteen days. This was accomplished only by working every man available day and night and during this time the air compressors and much other machinery in the shop never stopped.

The foregoing is an advance printing of a paper to be read before the Brooklyn Engineers' Club by Mr. William T. Donnelly, consulting engineer, 135 Broadway, New York, who planned the entire installation and designed the new pontoon dry dock.

USE OF STATIC ELECTRICITY IN THE SEPARATION OF MINERAL PARTICLES.

By Henry A. Wentworth.

SEVERAL years ago it was observed that minerals differ very greatly in electrical conductivity. Some, such as quartz, are among the poorest conductors, while others, of which pyrite is an example, are good conductors, belonging almost in the class with pure metals. As a rule, the close association of minerals in ores is such that comparatively fine crushing is necessary to free the constituents from one another.

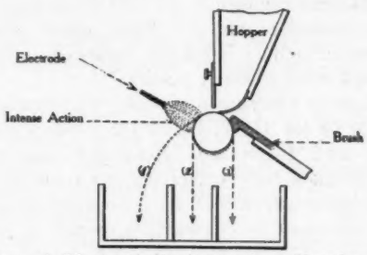


Fig. 1—Section of Electrostatic Separator, Showing Principle of Operation.

division to particles 0.05 in. in diameter or less being common. It has accordingly been found that the electrostatic forces which can be brought into play in a mineral mixture of conductors and non-conductors (or, more strictly speaking, of good and poor conductors, since all minerals seem to conduct electricity to some extent) may be relatively great as compared with the gravitational forces acting upon the constituents. Therefore, taking advantage of the well-known law that like charges repel while unlike charges attract, it was demonstrated that if a mixture of particles resulting from the crushed ore were dropped onto a charged metallic plate the particles of the better conducting material received their charges instantaneously and were repelled vigorously, whereas the poorer conductors received practically no charge. By properly catching the repelled portion separately from the unrepelled, a separation of the ingredients was effected.

In the mining world most of our supply of lead, zinc and copper, as well as a great deal of our gold and silver, is derived from the sulphide minerals, which sulphides are, as a rule, very definite in their relation to electrical conductivity; the sulphides of lead, iron and copper being excellent conductors, while the sulphide of zinc is, as a rule, a very poor conductor. Generally speaking, rock and various worthless vein-filling materials are also only slightly conductive.

Referring metallurgically to these minerals when occurring together, three separations are essential. First, the separation of the various sulphide minerals from the accompanying rock; second, the separation of the lead minerals from those of copper and zinc (but not necessarily of iron); third, the separation of zinc sulphide from all the other sulphides. Lead sulphide is much heavier than the other common sulphides, and all the sulphides are heavier than most of the rocks with which they occur, so that it is possible by means of gravity to concentrate the lead minerals by themselves (which is desirable) and to concentrate all the sulphides from the accompanying rock. There now remain together the zinc, iron, and copper minerals, and it is essential that the zinc be separated from the other two in order to obtain high efficiency and low cost of extraction in both the zinc furnace and the copper furnace. This separation, which cannot be done efficiently by gravity, has been one of the inducements for the development of electrostatic separation and one of its largest uses since commercial development. Another problem, of great importance from the metallurgical standpoint, is the concentration of many sulphide minerals from certain rocks of high specific gravity, such as barite, garnet, and epidote, in which rocks or "gangue" the sulphides often occur in large bodies. These rocks, as a rule, are of very low conductivity, so that electrostatic separation offers an efficient means for the concentration of the sulphides. Regarding the separation of the poor conductor, zinc sulphide, present in these rocks more will be noted later.

Having thus indicated very briefly a few important applications of this principle when developed, it will be shown how these results have been accomplished.

It was soon learned that not only could the good conductors be charged and repelled, leaving the poor conductors apparently inert, but also, if the particles were not too heavy, the differences in potential between the surface of the poor conductors and the surface against which they rested were sufficient to cause them to cling to the surface until brushed off. This effect was intensified by causing the mineral mixture to be sprayed with ionized air, whereby the poor conductors received a comparatively dense charge, different from that of the surface on which they rested. The better conductors, of course, conveyed this charge to the surface as fast as received.

To keep a metallic roll or surface insulated while charged at a potential of 50,000 volts or 60,000 volts, simultaneously supplying that surface with a stream of particles of which a large portion might be excellent conductors, proved a very difficult task. With the dust, dirt and moisture of the average mill, the problem was well-nigh impossible of solution. Therefore came the study of a combination of the grounded metallic surface onto which the ore might be fed, with an electrode placed opposite it, forming an electrostatic field which could be varied in intensity by changing the distance between the surfaces and

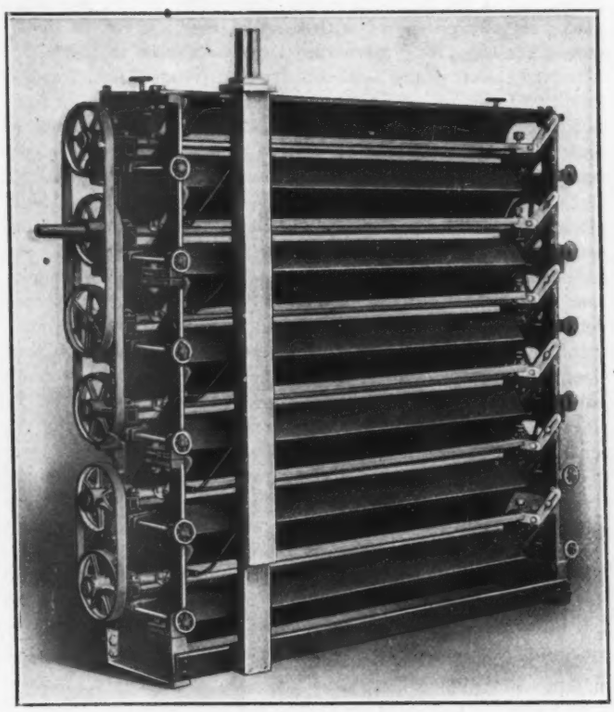


Fig. 2—Electrostatic Separator.

by altering the potential difference applied. This arrangement is illustrated in Fig. 1. By this solution of the problem, those parts of the mechanism which must necessarily come in contact with the ore and the persons of the workmen could be grounded, while a highly charged opposite electrode could be carefully insulated. Furthermore, this adaptation permitted the use of metal for all the wearing parts, resulting in longevity of the machine. In the accompanying illustration, Fig. 2, is shown a Huff electrostatic separator. This is almost entirely of metallic construction; and yet a potential of from 18,000 volts to 40,000 volts is maintained between the electrodes. By comparing the machine with the sketch illustrating the principle,

Fig. 1, the action is readily understood. The dotted paths numbered 1, 2, and 3 indicate the directions taken by the various particles, those of greatest conductivity following No. 1, under certain electrifications, and No. 2 under others, while the poorer conductors follow No. 3. Because of a certain amount of mechanical interference of the particles while passing through the electrostatic field, the best work is obtained by using several successive fields, as shown in the cut.

To obtain an electrification of the electrostatic separators by a means which should supply sufficient energy to take care of the line and machine losses in a large mill; which should not be dangerous to the operators at 30,000 volts or more in case of accidental contact; of which the potential should be capable of easy and convenient regulation, and of which the operation might easily be changed from a practically steady condition to a series of extremely sudden changes separated by inert intervals, was a problem which, though fairly simple when solved, offered a great deal of difficulty to the investigators. Naturally the static machine was first used, but the difficulties of obtaining a sufficient output and yet close regulation of potential, especially in moist climates, soon side-tracked this source of electricity. There has accordingly now been developed a system embracing a special alternator, transformer and interrupter which fulfils the conditions set forth. With one set of apparatus large mills are supplied with electricity at 20,000 volts to 35,000 volts, with as simple wiring and care as are required by the lighting system. This electrical apparatus is placed in the engine room of the mill. If steam drive is used, a separate engine is used to operate the generator, to insure steadiness of the potential in the static fields on the separating machines. By means of a rheostat in the field of the generator the voltage on the separators can be altered at will.

In the electrostatic mill of the American Zinc, Lead & Smelting Company, at Platteville, Wis., which has been in practically continuous operation since March, 1908, a supply of material of about 80 tons per day of blende and marcasite concentrates is obtained from the various jig mills of the district, and is separated by the electrostatic plant, producing a high-grade zinc product for the zinc smelters and a marcasite product valuable for its available sulphur for the sulphuric-acid and gunpowder manufacturers. The ore, entering on the higher side of the mill, passes through a rotary dryer, and is then delivered to an elevator which raises it to the top of the mill; thence it flows by gravity over screens separating it into four sizes from 0.16 in. down, the oversize from the largest mesh going to a set of crushing rolls and thence returning to the elevator. From the screens the ore material passes to the separators and into the finished-product bins on the lowest floor of the mill. This mill operates twenty-four hours a day (three shifts). In the operation of separators it is often found best to arrange them in units consisting of a roughing machine on one floor and a cleaner for each product on the floor below, the middlings resulting from the procedure passing into the elevator boot and thus back through the system. This general scheme is followed in the electrostatic mill of the United States Smelting, Refining & Mining Company at Midvale, Utah, and in other electrostatic mills.

Zinc sulphide, or blende, as above mentioned, is when pure a very poor conductor of electricity. Blende, however, seldom occurs pure, but usually has in chemical combination with it varying amounts of iron, manganese or other element, and this combination is more conductive than is the pure blende itself. As the impurity increases in amount the conductivity increases also, although it is not certain that there is any definite relation between the amount of impurity and the conductivity. With small amounts of impurity there is no appreciable effect from an electrostatic standpoint, and excellent separations of blende containing as much as 12 per cent of chemically combined iron have been made electrostatically from chalcopyrite and pyrite. One of the recent developments of the process has been its application to the so-called "black-jack" zinc problems.

It has been found that if resinous non-conducting blende be immersed in a very dilute solution of copper sulphate, its conductivity from an electrostatic standpoint (when it is again dry) suddenly becomes very different from what it was before, the blende now being readily separable from the poorly conducting rocks, which have been unaffected. By this treatment the blende is darkened, but the surface, even under a powerful microscope, does not show difference from its original condition. Other means have been found for altering the conductivity of minerals so that separation may be effected between two minerals which in their natural state act very similarly in electrostatic separation. Limonite, one of the ores of iron, is a very indifferent conductor. If it be roasted to drive off the chemically combined water, the ferric oxide remaining is a very good conductor and is readily separable from the gangue rock and clays with which it occurs.

An investigation covering practically all the known minerals has been made by Mr. G. W. Pickard, consulting electrical engineer for the Huff Electrostatic Separator Company, who has prepared a complete table embracing 221 minerals which were found to be good conductors in the sense that they can be successfully separated by electrostatic means.

THE DESIGN OF SHUNT FIELD WINDINGS.

By Frank W. Merrill.

IT is the purpose of this article to consider the relation between different variables entering into the design of the shunt field windings of dynamo-electric machinery, and to describe and illustrate a method of design that several years of actual experience have shown to be accurate and direct. That part of the design pertaining to the calculation of the relative amounts of two sizes of wire to be wound on a given field coil, to obtain amp-turns intermediate between those corresponding to the two sizes has recently been worked out by the author and is believed to be entirely new.

The magnetic circuit of any direct-current motor or generator is similar to a multiple-series battery circuit. The simplest form is the bi-polar machine, having one north and one south pole. The m.m.fs. of the two field coils are here connected in series, so to speak, since their combined efforts serve to drive the entire flux around the length of the magnetic circuit. In the case of a four-pole machine the poles are alternately north and south and there are, magnetically considered, two in series and two in parallel. One pair of poles—a north and a south—drives *half* of the total flux of the machine entirely around the length of the magnetic circuit. The other pair of poles drives the other half throughout the same length of circuit, but in a different part of the machine. Thus there are two pairs of poles magnetically connected in multiple. By way of further illustration there would be, in the case of a twelve-pole machine, two in series and six in parallel; and in the case of a machine with any number of poles there would always be two in series and as many in multiple as there are pairs of poles.

Considering the multiple-series battery circuit, the number of cells in series determines the voltage or pressure of the battery. When the method of connection is once established the voltage of the battery will depend entirely upon the voltage which one cell can generate. In the case of the system of field coils the method of connection is established by an absolute law —*there are always two in series.* This being the case, the magnetic pressure—or amp-turns—required to send the flux through the length of the magnetic circuit must be supplied *on each pair of poles.*

Electrically speaking, however, it is customary to connect all of the field coils in series, regardless of their magnetic relation to one another. This method of connecting the windings of the coils will be assumed throughout the remainder of the article.

Suppose that the magnetic circuit of a six-pole shunt motor

has been calculated, and that the number of amp-turns needed per pair of poles to send the required flux through the frame, magnet core, air-gap, teeth and armature core is known. The mechanical dimensions of the motor, such as the size of the poles or of the form on which the coils are to be wound, the limiting size of the coils themselves, and all other dimensions of the motor are also known. The unknown elements are the size of the wire and the number of turns per coil to be wound on the shunt coil. The first step in finding these unknown quantities is accomplished by the use of the following formula:

$$M_c = \frac{1.035 \times IT \times L_m \times 3}{E}$$

Let us now consider in detail the different terms of the above formula, and then illustrate its use by means of a practical example.

(1) E in the denominator stands for the line voltage for which the motor is to be wound.

(2) The expression L_m is the length in inches of the average turn of wire on one of the field coils. (L_m is an abbreviation for "length of mean turn.")

(3) IT is the number of amp-turns wanted per pair of poles.

(4) The constant 3 stands for the number of pairs of poles magnetically connected in parallel.

(5) The constant 1.035 represents the conductivity of the wire, and its value depends upon the material of which the wire is made, and upon the temperature of this material. The above constant is for pure copper at a temperature of 75 deg. C., which is estimated to be the actual temperature of the wire when the coils show a rise by thermometer of some 40 deg. C. above the surrounding air. This condition may for convenience be called "hot." If the coils now be allowed to cool to the temperature of the room, say, 20 deg. C., or 68 deg. Fahr., the value of the constant becomes 0.863, because the material has increased in conductivity. This will be more clearly explained a little later.

(6) The term M_c is the most important of all. It is the unknown cross-section of the wire in circular mils.

Analyzing the formula it will be seen that the value of amp-turns depends upon, first, three variables which are merely dimensional in nature. These are cross-section of wire, length of average turn and the number of pairs of poles. Another term which influences the value of the field strength is the line voltage, but this is always fixed by the kind of service available. The remaining factor—the constant 1.035—involves the material and temperature of the wire, which may be considered constant for the average operating condition. It is evident, therefore, that as soon as the voltage and general dimensions of the coils are fixed the amp-turns will vary directly as the cross-section of the wire.

Derivation of the constant 1.035.

Resistance of one mil-foot of copper at 20 deg. C. (68 deg. Fahr.) = 10.35 ohms.

$$\text{Resistance of one mil-inch} = \frac{10.35}{12} = 0.863 \text{ ohm.}$$

Resistance of copper will increase 1 per cent for each 2.5 deg. C. rise in temperature. Assume that the coils reach an average hot operating condition when the temperature rise has become 50 deg. C. This represents an increase in resistance of $50 \div 2.5 = 20$ per cent. The resistance of one mil-inch of copper under this condition $= 0.863 \times 1.2 = 1.035$.

The constant 0.863 would be used in the formula when it was desired to determine the amp-turns with the copper *"cold."*

The constant 0.863 increased by 10 per cent to 0.95 would be used when the average temperature of the coils might be described as *"warm"* (25 deg. C. rise).

When round wire is wound on a field coil former in even layers, one wire directly on top of another, it is evident that the space or cross-section occupied by each wire is equal to the square of the diameter of the wire measuring over the insulation. That is, considering no bedding of one wire into the spaces between two others, it may be said that each wire occupies the area of the square circumscribed about it. This kind of winding is numerically described by the space factor 0.7854—which is the ratio of the area of a circle to the area of the square of its diameter.

If the diameter of the insulated wire is D, and the number of turns per coil is N, then the cross-sectional area of the coil $= D^2N$.

In ordinary careful winding there will be some crossing over

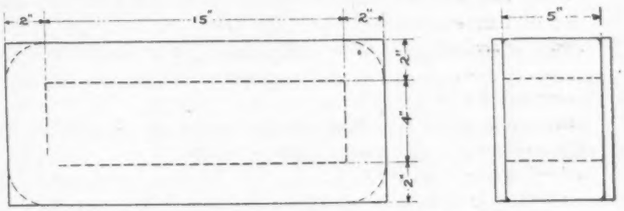


Fig. 1—Dimensions of Field Coils.

and piling up of wires, and there will also be much bedding of wires into the spaces.

It is believed that these two effects approximately offset each other, so that the space factor 0.7854 most nearly represents actual conditions.

Field coils are usually wound on forms, but some times directly on the poles. The shape of the pole or form is not always round. It may be oval, rectangular, or some other peculiar shape. *Whatever this shape may be, however, it can be reduced to an equivalent circular section.*

Suppose that the coil is to be wound on a form of the section

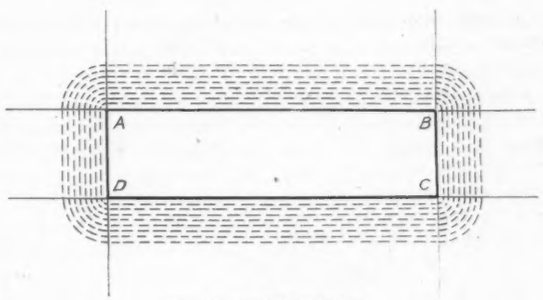


Fig. 2—Coil Windings.

shown in Fig. 1, and that the maximum sized coil that can be placed in the machine will be produced when the coil is wound 2 in. deep—that is, level with the top of the form. D^2N maximum is here equal to $2 \times 5 = 10$ sq. in. The equivalent circular section of the coil former may now be found. The perimeter measuring around the former $= 15 + 4 + 15 + 4 = 38$ in. $38 \div 3.1416 = 12.1 =$ the equivalent diameter of the coil former.

The accuracy of this method of procedure can be seen by referring to Fig. 2. Here the wire wound on the form is represented by dotted lines. It will also be noticed that the lines *AB, BC, CD,* and *DA* have been produced so that they extend outside of the coil. Those portions of all turns of wire

Fig. 3—Reduced Diagram of Field Coil.

in the coil lying opposite the straight sides of the form and parallel to them are of the same length. On each corner of the form will be noticed the wire bending through the quadrant of a circle. Combining the four corners and the four quadrants there is obtained a complete circle. Each turn of wire is, therefore, made up of two parts, a constant length, *ABCDA*, and a variable length, which is function of the depth of the layer and of 3.1416. The variation in length of turn with the

depth of the wire in the coil is, therefore, a function of 3.1416, and the field coil form whatever its shape may for convenience be at once reduced to an equivalent circular section in the manner described above.

Fig. 3 represents the conventional diagrammatic figure to which any field coil form may be reduced, to facilitate computation.

D = the equivalent diameter.
L = The length of one layer of wire.
T = The maximum allowable thickness to which the coil may be wound.

Then TL = the area of winding space = D^2N, where D^2 = the square of the diameter of the insulated wire and N = the number of turns in the coil.

Insulation adds approximately the following amounts to the diameter of any wire, expressed in inches:

Double cotton	0.0090
Single cotton	0.0045
Double silk	0.0040
Single silk	0.0020
Single silk and single cotton	0.0060

Example:—

Given the field form shown in Fig. 4, required 7500 amp-turns per pair of poles when the motor is hot. The motor is

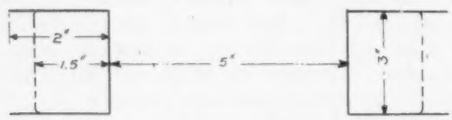


Fig. 4—Dimensional Reduced Diagram of Field Coil.

a 450-volt, four-pole, shunt-wound machine. The heating is not to exceed 0.42 watt per square inch of total external surface of coil.

Assume that the form is wound three-quarters full—that is, to a depth of 1.5 in. The mean diameter of the coil = 5 + 1.5 = 6.5 in. Length of mean turn $L_m = 6.5 \times 3.1416 = 20.4$ in.

Then $$\frac{1.035 \times IT \times L_m \times \text{pairs of poles}}{E} = M_c$$

substituting the known values,

$$\frac{1.035 \times 7500 \times 20.4 \times 2}{450} = 705$$

This calls for a size of wire intermediate between No. 22 and No. 21 B. & S. gage. No. 21 will give too many amp-turns, No. 22 too few. This detail, involving the relative amounts of the two sizes to be used, will be thoroughly worked out a little later.

Estimate now the coil for No. 22 wire in order to illustrate the method.

0.0253 = diameter of bare wire.
0.0045 = increase of diameter due to single cotton insulation.
0.0298 = diameter of insulated wire.

$$D^2 = (0.0298)^2 = 0.00089.$$

Allowable D^2N or sectional area = 1.5×3 for the first trial = 4.5 sq. in. Number of turns (N) of No. 22 wire which can be got into this space = $\frac{4.5}{0.00089} = 5000$. $L_m = 20.4$. Total feet of wire in the four field coils of motor = $\frac{5000 \times 20.4 \times 4}{12}$ equals 34,000.

Referring to the B. & S. wire table it is found that this amount of No. 22 wire has a resistance of 550 ohms at 68 deg. Fahr. Its hot resistance will be 20 per cent higher, or 660 ohms. Field amperes = 450 ÷ 660 = 0.68. Amp-turns per pair of poles = $5000 \times 2 \times 0.68 = 6800$. Since 7500 amp-turns are required, the prediction of the formula that No. 22 wire would give too few amp-turns, is borne out.

It is well now to investigate the heating of the coil. $I^2R = 450 \times 0.68 = 306$ watts. Total external surface of coil = perimeter $\times L_m \times$ number of coils = $(1.5 + 3 + 1.5 + 3) \times 20.4 \times 4 = 740$ sq. in. $306 \div 740 = 0.42$ watt per square inch nearly—which experience has shown to be about the correct value for continuous-service open motors with an average amount of ventilation.

The coil is now correct from the standpoint of heating, but it does not yet produce the required number of amp-turns. The formula has shown that the correct size of wire lies somewhere between Nos. 21 and 22. The calculation for No. 22 has shown that this wire alone will give only 6800 amp-turns—the required number being 7500.

The B. & S. wire table is designed according to the law of geometrical progression, and the consecutive sizes of wire differ from one another by a *factor* of 1.26, which is equal to $\sqrt[3]{2}$. Hence a wire three sizes smaller in number than a given wire will contain $1.26 \times 1.26 \times 1.26 = 2$ times as many circular mils, because the factor $\sqrt[3]{2}$, or 1.26, is used three times, which is the same as the factor 2 being used once. Another way of looking at this relation between consecutive sizes of wire is to note that the increase in cross-section and weight from any size to that next smaller in number is 26 per cent.

Hence, No. 21 wire has 26 per cent more cross-section than No. 22, and if used alone on the field coils would give 26 per cent more amp-turns. Therefore, the coil, if wound with No. 21 wire alone, would give $6800 \times 1.26 = 8560$ amp-turns. This value is too great.

In order then to obtain exactly 7500 amp-turns the coil must be wound partly with one size and partly with the other—connecting the two sizes in series so as to obtain the effect of a fractional size. After some experience one can estimate quite closely how many turns of each to wind, but this method is only guesswork and does not appeal to the careful designer.

What is needed is a formula that will supplement the general equation for obtaining the circular mils, and show at once the number of turns of each size of wire to wind on the form within a given depth to produce the required number of amp-turns. Such a formula is entirely possible, and the method of its derivation will now be discussed.

Suppose that the general formula has been applied and it has been found that the size of wire required lies between the sizes S_1 and S_2. Suppose that the coil has been wound entirely with S_1, thereby producing a result either too small or too large. It is necessary, therefore, to substitute a certain number of turns of S_2 for some of the turns of S_1. The cross-sectional area, D^2N, of the first size of wire tried = A_1. The area of the winding space of the second size substituted for part of the first = A_2. If addition is made of *larger* wire, the amp-turns of the first size become affected by a factor of *increase* greater than unity. If addition is made of *smaller* wire, the amp-turns of the first become affected by a factor of *decrease* greater than unity. By changing its name, the factor is thus kept always greater than unity, whether larger or smaller wire is to be added.

Let F be this factor.

Then $$\frac{(A_1 - A_2) + (A_2 \times 1.26)}{A_1} = F$$

$$A_2 = \frac{A_1 (F - 1)}{0.26} \qquad (1)$$

For A_1 there may be substituted the number of turns of the wire first tried as proportional to A_1. A_2 will then be obtained in terms of this unit. To determine the number of turns of the second size, if smaller, one should multiply by 1.26, and if larger divide by 1.26 for bare wire.

Then $$T_s = \frac{T_L (F - 1)\ 1.26}{0.26} \qquad (2)$$

Where T_s = the number of turns of the second size used if this size be the smaller.

And $$T_L = \frac{T_s (F - 1)}{0.26 \times 1.26} \qquad (3)$$

Where T_L = the number of turns of the second size used if this size be the larger.

The constant 1.26 used in the above is true for bare wire only, and represents the ratio between the values of D^2 for two consecutive sizes, D^2 being the square of the diameter of the wire.

With insulated wire, however, the ratio between sizes is not 1.26—but is somewhat less, due to the effect of the addition to each size of the same thickness of insulation, which in small wires tends very much to equalize the space occupied by the two wires being compared.

EXAMPLE NO. 1.

	No. 31 single cotton.	No. 30 single cotton.
Diameter of bare wire.....	0.0089	0.0100
Single cotton insulation....	0.0045	0.0045
Diameter insulated wire....	0.0134	0.0145
	$D^2 = 0.000179$	$D^2 = 0.00021$

$$\text{Ratio } \frac{0.00021}{0.000179} = 1.17$$

EXAMPLE NO. 2.

	No. 13 single cotton.	No. 12 single cotton.
Diameter of bare wire.....	0.0720	0.0810
Single cotton insulation....	0.0045	0.0045
Diameter insulated wire....	0.0765	0.0855
	$D^2 = 0.00585$	$D^2 = 0.00731$

$$\text{Ratio } \frac{0.00731}{0.00585} = 1.25$$

The above examples show that for large wires the insulation is of small moment and that the ratio of D^2 for two consecutive sizes approaches the bare wire value of 1.26.

In order to make formulas (2) and (3) as accurate as possible one should substitute the ratio of an average size of wire in place of the bare wire ratio 1.26. The ratio between No. 23 and No. 24 B. & S. single cotton covered is 1.20, which has been chosen as a fair average. This value having once been assumed, it will be found that the formula is quite accurate for all sizes, as the insulation ratio is really a variable of the second order, so to speak.

Substituting,

$$T_S = \frac{T_L\,(F-1)\,1.20}{0.26} \text{ or } T_S = T_L\,(F-1)\,4.6 \qquad (4)$$

$$T_L = \frac{T_S\,(F-1)}{0.26 \times 1.20} \text{ or } T_L = T_S\,(F-1)\,3.2 \qquad (5)$$

Formulas (4) and (5) are now in their final form.

Referring again to the example based on the field form shown in Fig. 4, one may easily illustrate the method of use and the accuracy of the above formula.

GENERAL FORMULA.

$$M_c = \frac{1.035 \times 7500 \times 20.4 \times 2}{450}$$

$= 705$ intermediate between sizes Nos. 22 and 21.

	No. 22.	No. 21.
Bare	0.0253	0.0285
Insulation	0.0045	0.0045
Insulated	0.0298	0.0330
	$D^2 = 0.00089$	$D^2 = 0.00109$.

Allowable D^2N for each size $= 4.5 - \frac{4.5}{0.00109} = 4100$ turns of No. 21 if wound entirely of this size. No. 21 wire has an area of 812 circ. mils. Then $F = 812 \div 705 = 1.15$.

Use can now be made of formula (4) to solve for turns of No. 22, thus $T_S = 4100\ (0.15) \times 4.6 = 2820$ turns of No. 22.

Ratio $D^2 = 0.00109 \div 0.00089 = 1.22$; 2800 turns of No. 22 will then replace $2800 \div 1.22 = 2300$ turns of No. 21. $4100 - 2300 = 1800$ turns of No. 21 left.

The smaller size should be wound on the bottom.

2800×4	1800×4
No. 22 single cotton.	No. 21 single cotton.
$D^2 = 0.00089$	$D^2 = 0.00109$
$D^2N = 2.5$	$D^2N = 1.96$
$2.5 \div 3 = 0.83$ in. depth of No. 22. wire.	$1.96 \div 3 = 0.66$ in. depth of No. 21 wire.
5.00 mean diameter (see Fig. 4)	5.00
0.83	0.83
	0.83
5.83	0.66
$5.83 \times 3.1416 = 18.4 = L_m$.	7.32

$7.32 \times 3.1416 = 23.0$ in. $= L_m$.

$2800 \times 18.4 \times 4 \div 12 = 17{,}200$ ft.

$1800 \times 23 \times 4 \div 12 = 13{,}800$ ft.

Resistance hot No. 22 wire = 336 ohms; resistance hot No. 21 = 212 ohms; total resistance = 548 ohms. Shunt-field current = $450 \div 548 = 0.82$ amp.

Turns of wire per pair of poles = $(1800 + 2800)\ 2 = 9200$.

Ampere-turns per pair of poles = $9200 \times 0.82 = 7550$, which is accurate to within one-half of 1 per cent.

The above may seem a long process when it is studied through for the first time, but by making the computation on a slide rule, and using either formula (4) or (5), in connection with the general equation for obtaining circular mils, it will be found that shunt-field coils can be proportioned both rapidly and accurately.

It is not the purpose herein to discuss to any extent the subject of the heating of field coils, but a few general statements may safely be made.

The temperature to which a field coil will rise depends upon two things, namely, the rate at which energy (I^2R loss) is liberated and the rate at which this heat energy can be carried away. In order to reduce the number of watts liberated in the coils it is necessary to use a large amount of copper so as to obtain the required ampere-turns with the smallest possible current.

It may be noted in passing that on a constant-potential circuit the ampere-turns are independent of the actual number of turns and may be varied only by changing some of the variables given in the general formula for circular mils. The large number of turns is, therefore, put on the field coils solely for the purpose of reducing the heating.

With the size of the motor frame fixed, the limiting size of the field coils becomes fixed, and the safe heating limit will then determine how many ampere-turns may be obtained.

Heat may be removed from the coils in three ways, namely, conduction, convection and radiation. Of these three, convection—the removal of heat by the circulation of air around the coils—is by far the most important. The author would estimate from his experience with this kind of work that 70 per cent of the heat is removed by convection. In an open, well-ventilated motor the permissible loss may run from 0.4 watt to 0.5 watt per square inch of total outside surface of coil for continuous service. In a fully enclosed machine, however, this value should be reduced to about 0.2 watt per square inch.

ELECTRICITY TO THE AID OF GAS.

A recent issue of a gas-lighting paper calls attention to the disadvantages attending the use of matches for illuminating the disk on gas meters and to the advantageous features of portable electric lamps for this purpose. It is stated that at the present time, when electric pocket torches of convenient size are available, there is no excuse for any gas company following the old-fashioned way of holding a naked lamp near the dial of a meter.

AMERICAN SWITCHBOARD PRACTICE.—II.

Influence of Distant-Control Switchgear on Alternating-Current Station Design.

By Stephen Q. Hayes.

In the previous article the writer traced the influence of switching apparatus on the design of rotary-converter substations and also on main generating stations; the subject being divided into and treated under three sections, the first two of which, converting stations and generating stations, were covered in the first article.

TRANSFORMING STATIONS

As explained in the first portion of this article, the term "transforming stations" is applied to any generating station where the main portion of the output has its voltage stepped up by means of transformers and the energy thence fed out to the transmission lines, or where high voltage is stepped down by means of transformers before the energy is distributed to the various feeder circuits.

All of the previous illustrations have indicated the use of circuit-breakers in fireproof masonry compartments, such as

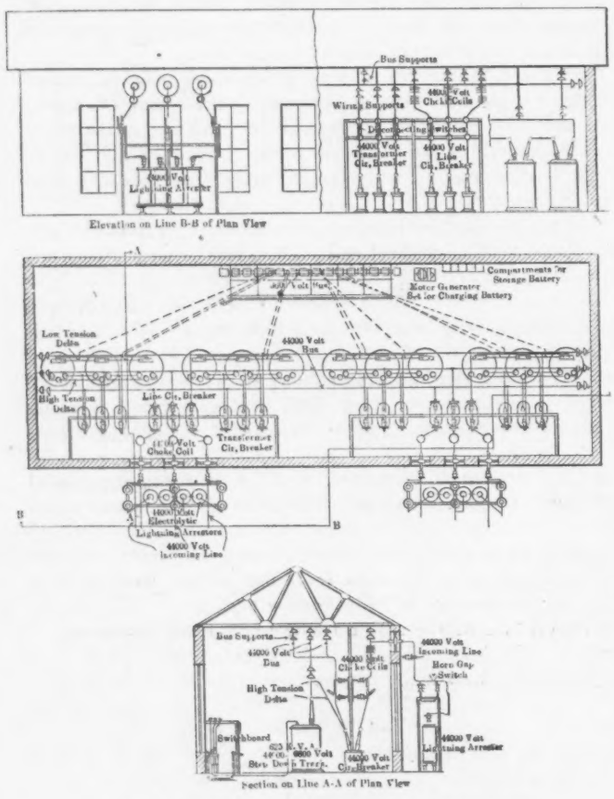


Fig. 1—Transforming Station, 44,000 Volts.

have been supplied in practically all of the large stations, and the switching equipment is arranged in these masonry compartments in such a manner that leads of opposite polarity are separated by soapstone, concrete, brick or similar material. These fireproof walls, barriers, etc., prevent an arc forming in one place and communicating to adjacent conductors. The amount of current available momentarily at the point of trouble in large stations of 13,200 volts or less where the generators are connected to a common bus is something enormous and every precaution must be taken to prevent trouble from arcs spreading. For such voltages the question of suitable insulation distances between the live metal parts and the masonry structure is comparatively simple.

Where the generators connect through step-up transformers giving voltages from 22,000 to 135,000, or even higher, the question of enclosing the busbars and wiring for the high-tension circuits becomes an entirely different proposition. Some engineers are of the opinion that the cellular construction should be used for large circuits of any voltage and bottom-connected breakers have been designed that work in well with the enclosed busbar construction for high-voltage plants, as shown in Fig. 2. In the writer's opinion, however, the open system of wiring is preferable for any voltage higher than that for which generators can be conveniently wound.

The writer's opinion relative to the advisability of open busbars and wiring for high-voltage circuits is based on the following reasons: (1) The violence of an arc and the destructive effect of a short-circuit depend on the amount of current available at that point and are inversely proportional to the voltage for the same amount of power. While fireproof barriers and cellular constructions are required on large plants of comparatively low voltage, they are unnecessary for higher voltage plants of the same or even larger output. (2) The distance from wire to ground has to be greatly reduced over what could be obtained with open wiring in the same space, as the fireproof barriers offer a more or less perfect ground for high-voltage circuits, and the higher the voltage the more perfect the ground. (3) A more expensive building and costly construction are usually needed for enclosed busbars and wiring than are required for open wiring. (4) Inspection and repairs are more difficult for busbars, wiring disconnecting switches and similar appliances that are boxed in masonry compartments and are only visible and accessible by the removal of doors, than if everything was in plain sight. Inspection will be more frequent and thorough and incipient trouble will be noticed far sooner with open wiring than with enclosed, as the station attendant in a few minutes' walk can see everything and will not have to remove many doors and visit two or three floors to examine the condition of the apparatus.

Fig. 1 shows a transforming station intended for the control of two 44,000-volt, three-phase incoming lines, four banks each of three 625-kva step-down transformers and a number of 6600-volt, low-tension feeder circuits. As may be noted, the 44,000-volt incoming lines enter through a suitable wall bushing and then pass through the open helical choke coils and disconnecting switches into the oil circuit-breakers and from the oil circuit-breakers through a second set of disconnecting switches to the 44,000-volt busbars hung from suspension insulators. Passing back from the 44,000-volt busbars the connections go through disconnecting switches into the oil circuit-breaker and thence to the high-tension side of the step-down transformers. A panel-type switchboard with manually operated oil breakers located on the station wall takes care of the 6600-volt circuits.

In order to illustrate more clearly the difference in the design of the station made necessary by the use of enclosed busbars for the high-tension circuits, Fig. 2 has been prepared for the purpose of comparison. This station shows three different designs of switching equipment for the control of two 15,000-kva, 66,000-volt, three-phase incoming lines and four 7500-kva, three-phase step-down transformers supplying energy to two sets of 13,200-volt busbars, which in turn supply both underground and overhead feeders. Section "A" shows the general arrangement of the circuit-breakers, busbars, connections, etc., using bottom-connected breakers of standard design and arranging to locate the 66,000-volt busbars, with their disconnecting switches, on the lower floor. With this arrangement the control desk, the low-tension breakers and the high-tension breakers are all placed on the upper floor. In order to provide sufficient headroom for lifting the coils and iron out of the transformer case, it is necessary to slide the transformer into the passage way and then run it on a truck to the central portion of the building, where the floor has been raised under the control desk in such a manner as to provide the necessary head room. With this arrangement it may be noted that the total height of the building required from the floor line to the roof girders is 47 ft. 6 in. The high-tension

incoming line breaker and the breakers for the high-tension side of the step-down transformers are arranged in two rows in order to provide sufficient space for the breakers.

Section "B" shows the arrangement necessary to use top-connected breakers and still to enclose the busbars. With this arrangement the 66,000-volt busbars, as well as the 13,200-volt circuit-breakers with their busbars and the control desk, are placed on the upper floor, while the 66,000-volt breakers themselves, with their disconnecting switches, are located on the main floor near the transformers. With this arrangement a somewhat smaller amount of headroom is required, and any transformer can have its coils or iron removed as soon as it is slid out into the passage way. The building arranged in this manner requires a height of 37 ft. 6 in. from the floor line to the roof girders and requires a second floor, the same as shown in section "A." Section "C" shows the arrangement of this same station with top-connected breakers and open busbars

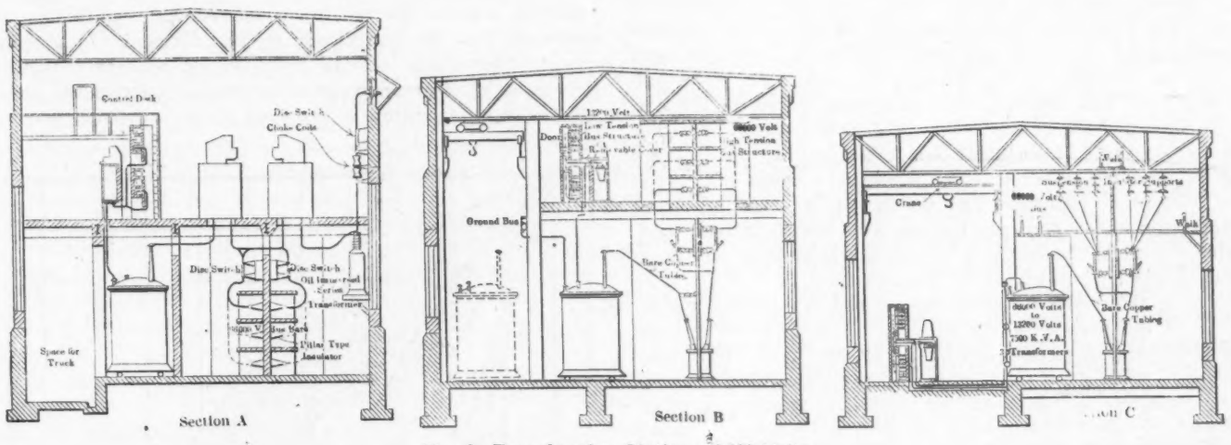


Fig. 2—Transforming Station, 66,000 Volts.

and wiring for the 66,000-volt circuits. With this arrangement there is no necessity of any second floor, all of the apparatus is placed on the one level and the height of the building is greatly reduced, as the distance from the floor line to the bottom of the roof girders is only 30 ft.

Needless to say, the plan indicated in section "C" is by far

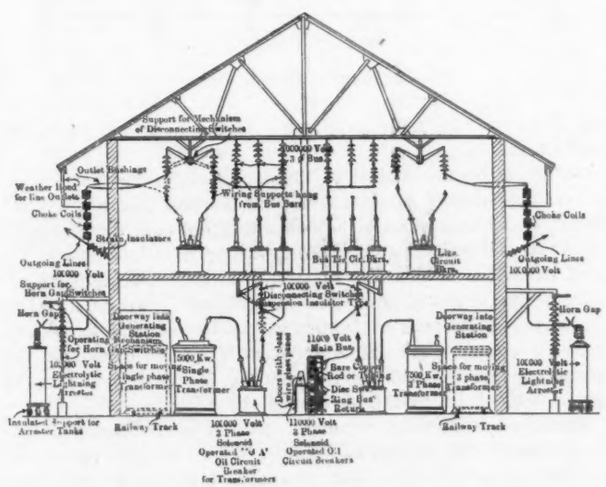


Fig. 3—Transforming Station, 100,000 Volts.

the cheapest with respect to the cost of the building itself. In sections "B" and "C" the design of the circuit-breakers is such that there is ample space to place the line breakers and the breakers for the high-tension side of the step-down transformers in one continuous row. These three sections of Fig 2 clearly show how the design of the switchgear materially affects the design of the station.

Fig. 3 shows the sectional view through the transformer and circuit-breaker house of a proposed 100,000-volt station. This station is designed to contain eight 7500-kva generators, with provision for eight future generators. At the time when the designs were being drawn up two different transformer propositions were considered, one being to furnish eight 7500-kva, three-phase transformers, one for each machine, and the other to supply three 5000-kva transformers arranged in groups of three each to take care of the output of two 7500-kva generators. These transformers, whether in three-phase units or in single-phase units, would be used for stepping up the voltage to 100,000 volts and a large number of 100,000-volt feeder circuits would leave the station.

Both the high-tension and the low-tension circuits were arranged to form complete ring systems, and as the station is practically symmetrical around the vertical center line, one-half of the drawing on the right-hand side shows the connections for the three-phase transformers, while the corresponding arrangement on the left-hand side takes care of the single-

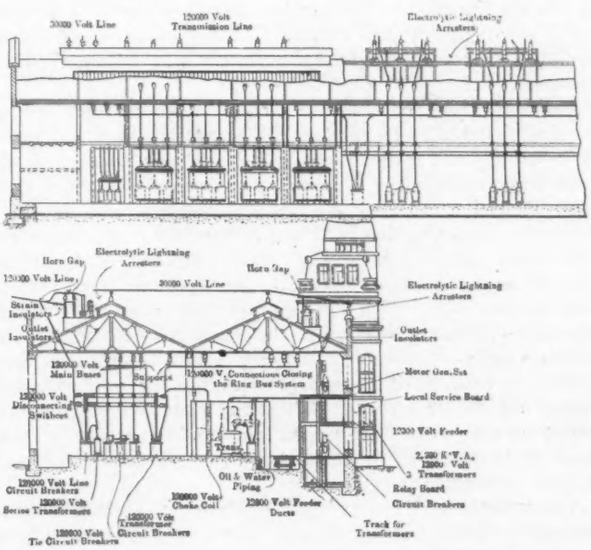


Fig. 4—Transforming Station, 120,000 Volts.

phase transformers. The 11,000-volt circuits are practically independent of whether three-phase or single-phase transformer units were to be supplied.

One particularly novel feature of this installation was the

type of disconnecting switches to be used in the 100,000-volt circuits. As indicated on this drawing, the disconnecting switches consisted essentially of a contact hung from suspension insulators, which contact could be lowered until it made connection with a rod projecting up from a condenser bushing. Flexible leads attached to the moving contacts connected to the station wiring in such a manner that these switches were practically single-break switches, and the three poles of a three-pole switch were operated by a single mechanism with a suitable indicating device. This type of disconnecting switches—namely, a combination of suspension insulators and condenser bushings—can be applied to practically any voltage that is apt to be reached in high-tension service. The oil circuit-breakers in this installation were provided with condenser-type series transformers clamped around the condenser bushings, and these series transformers furnish current for the ammeter and relays.

Copper tubing was to be used throughout for the busbars and wiring, the tubing being entirely bare and the busbars being hung from suspension insulators. Where wiring supports were needed additional suspension insulators, ordinarily hung from the busbars or busbar supports, were used. The outgoing lines pass through condenser bushings set in the outside wall, and the helical choke coils for the transmission line were suspended from these condenser bushings. The outgoing lines are anchored to the building by means of a series of suspension insulators and the suspension type of switch was made into a horn-gap for use with the electrolytic lightning arresters, the lightning arresters, choke coils and horn-gaps all being located out of doors.

Fig. 4 shows the elevation, section and the general appearance of the outside of the building for a proposed terminal station designed to take care of an ultimate total of six 120,000-volt, three-phase transmission lines, each capable of carrying 20,000 kva, 25 cycles; twelve 10,000-kva, 120,000-volt, three-phase step-down transformers and a large number of 12,000-volt, three-phase distributing circuits. The 120,000-volt circuits in this plant are obtained from star-connected transformers whose neutral point is to be solidly grounded, thus greatly reducing the insulation strain on the various portions of the equipment, and actually permitting the use of slightly smaller switching apparatus than was required for the 100,000-volt installation indicated in Fig. 3. As shown in the sectional view, it was the intention to bring in the 120,000-volt circuits through condenser-type bushings located in the roof of the building, and the 120,000-volt lightning arresters will be installed on the roof.

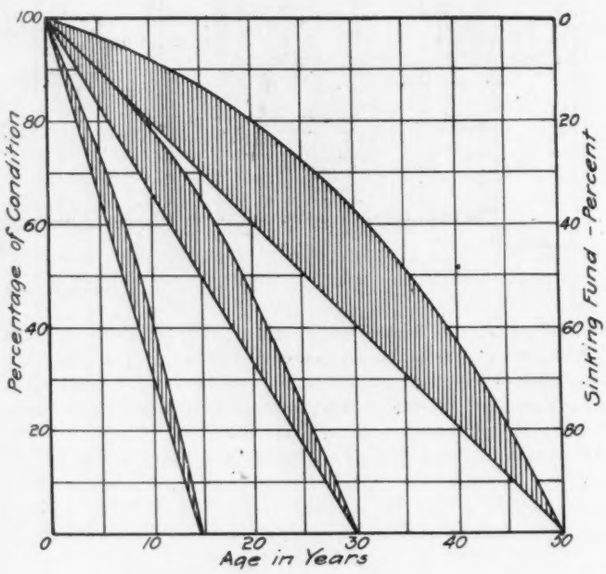
From the inlet bushing the circuit passes through disconnecting switches to the 120,000-volt circuit-breakers and series transformers and thence to other disconnecting switches to the high-tension bus, which is arranged to form a continuous ring. The connections are so made that under normal conditions each 20,000-kva incoming line will supply energy to two 10,000-kva step-down transformers. The 12,000-volt circuits from the step-down transformers pass through a circuit-breaker to a transformer bus. This transformer bus in turn connects through a second breaker to the main low-tension bus or through either of two other breakers to two group buses, each group bus being used for supplying energy for four 2500-kva, 12,000-volt feeder circuits. With this combination ring and group system on the high-tension and low-tension side, a great amount of flexibility is secured with a comparatively small number of switching appliances.

These various drawings of high-voltage plants indicate clearly the large amount of space required for the switching equipment and the great necessity of carefully considering the switching equipment before going deeply into the general design of the station. While it is felt that the illustrations and descriptions of these stations are comparatively meager, it is hoped that the information contained herein may be of some value in relation to the question of station design as influenced by switchgear.

DEPRECIATION IN ITS RELATION TO APPRAISALS.

Mr. Frank F. Fowle, a Chicago consulting engineer, was the principal speaker at the luncheon of the Electric Club of Chicago on Sept. 21. His subject was "Depreciation in Its Relation to Appraisals." Before treating of the specific aspect of depreciation indicated by the title of his talk, Mr. Fowle briefly discussed the subject of depreciation in general terms. It is universally admitted, he said, that all properties either appreciate or depreciate in value. Depreciation may be considered in relation to the cost of operation and also in relation to the value of the property. Considering the latter factor, the components to be considered are (1) wear and tear from use, (2) corrosion and decay, as in the case of poles for instance, (3) obsolescence, owing to advances in the art, and (4) inadequacy, owing to increasing business.

In any concrete case it is important to know the probable life of the property and also its rate of depreciation from year to year. In practice, the problem connected with depreciation is essentially how the depreciation shall be financed. In a going concern that which is to be provided for as depreciation is the cost of reconstruction minus the salvage value of the property. Depreciation must be provided for both in order to protect the investors in the property and also to afford funds for reconstruction.



Calculating Depreciation.

In taking up the subject of the appraisals of electrical properties, the speaker said that for this purpose there are three principal considerations to be borne in mind, and these may be classified as financial, economic and physical. Under the first named it is necessary to note the present cost of reproducing the property, and also its present depreciated value. There are differences of opinion as to the correct methods of arriving at these amounts. It may be observed that if the property is to be sold there should be a fair distribution of depreciation between the buyer and the seller.

Under economic considerations it is to be remembered that usefulness is the measure of value. The use or service may be uniform or periodic, and the value must be extinguished, therefore, in proportion to the use. The present value of the property is measured, under the economic consideration, by its remaining usefulness.

The physical considerations referred to have to do with the manner in which the wear and tear and corrosion and decay advance. Is the value measured by remaining unworn property? Is the wear uniform? If not, what should be taken as

the rate of wear? These are some of the questions to be answered.

Referring to the methods taken to provide for depreciation in actual practice, Mr. Fowle remarked first that there are some public-utility companies that make no such provision whatever. Some large concerns finance new construction out of earnings. Many companies make a partial provision in advance, and an increasing number of companies are endeavoring to make a full provision for depreciation in advance. The inquiries and investigations of the public-service commissions in various states have had something to do with the effort to provide fully for depreciation.

There are two principal methods for calculating depreciation in advance, namely, the sinking-fund method and what is known as the straight-line method. The first consists in setting aside a fund to provide a certain amount in a certain term of years, including interest compounded at, say, 4 per cent. The straight-line method assumes that the property depreciates regularly and gradually to a certain predetermined time, when it has no value.

The accompanying diagram was exhibited by Mr. Fowle to show the difference between the two systems. Taking three ages of the property, fifteen, thirty and fifty years, the straight lines indicate the percentage of condition for various intermediate periods, while the curved lines show the percentages of condition under the sinking-fund plan. The shading between the two lines in each case shows the difference between the two systems, the sinking-fund plan naturally revealing a higher percentage of condition. Opinions differ as to which of the two systems is the better. Personally, the speaker favored the straight-line method, and he remarked that the sinking-fund curve represents a condition that is wholly financial.

Mr. W. B. Jackson opened the discussion. He said that the subject of depreciation is a tremendously important one. The treatment of the problem goes right to the heart of the successful operation of public-service companies. It is to be remembered that a property depreciates as its individual parts depreciate. The individual unit of the whole property will depreciate from full value to salvage value during its life. When it comes to determining the amount of depreciation, the two methods mentioned by Mr. Fowle are to be considered. When analyzed there is not so much difference between these methods as might be thought. In the sinking-fund plan the interest on the fund is figured as a part of the earnings of the property. The payments into the sinking fund are in equal annual amounts, but the fund is increased by interest until the full wearing value of the plant is returned. Mr. Jackson rather favors the sinking-fund method. Probably the method of having the depreciation fund build itself up is the more logical of the two; but there is, after all, not a very great difference between the two plans. In one case a smaller amount is taken out of the earnings. In the other a larger amount is taken out, but the interest on the fund will be paid back into it to offset the larger amount taken out.

Mr. L. B. Marks, of New York, was invited to speak, but begged to be excused from discussing the subject in hand. He paid a compliment to the Electric Club of Chicago, however, for keeping together while the New York Electric Club has disbanded. This circumstance, he thought, might be due to the fact that the Chicago people are better "mixers."

President F. P. Vose who was in the chair, remarked that the little talks at the weekly luncheons of the club constitute a sort of post-graduate course for many of the members.

Mr. Harold Almert remarked that there is much confusion in terms in relation to depreciation. He spoke of a recent hearing in a federal court where the subject was under consideration. Of four or five experts who testified no two agreed in defining replacement value. He urged the engineers to make a study of the terminology of depreciation, so that exact and generally received definitions might be established. He agreed with the preceding speakers as to the great importance of the subject.

Mr. W. S. Taussig brought up the subject of bookkeeping methods, and Mr. Fowle explained briefly the method of "reducing balances," brought out in England. This, however, is more appropriate for certain kinds of manufacturing business where there are proportionately greater risks in the early years of the existence of the business. There is probably no method of figuring depreciation that will apply to all kinds of business.

LESSONS FROM ELECTRICAL ACCIDENTS.

Instructive lessons may almost always be drawn from the study of electrical accidents. The maintenance of continuous service and the prevention of injuries to both equipment and operators tax the skill of power-plant machinery designers and those in general charge of installations in commercial work. Whether the cause of a failure of apparatus be simple or complex, the recurrence of faults in the handling or service of machinery year by year warrants renewed reference to the subject. In the following notes the causes of a number of electrical breakdowns in the past year are reviewed, the experiences being those observed by a casualty company's engineers in close touch with failures of both steam and electrical apparatus:

The insurance company's records show that for the year 1909 40 per cent of the failures of generators resulted from defects in armatures or rotors. Twenty-nine per cent were due to faults in commutators and slip rings; 12 per cent to troubles with field coils and stators, and 3 per cent to brush rigging and terminals. Mechanical difficulties with shafts, spiders, cores, binders, pulleys and gearing accounted for 12 per cent of the failures, and 4 per cent of the troubles were due to defects in frames, pole pieces and bearings. In the case of motors the percentages of trouble were as follows: Armatures and rotors, 37; commutators and slip rings, 27; field coils and stators, 20; brush rigging and terminals, 4; rotating parts not carrying current, 7, and stationary parts not carrying current, 5. Among the troubles due to defects in starting switches and controllers, 52 per cent were in resistor coils, 9 per cent in contacts and switch arms, and 21 per cent in automatic apparatus, making 82 per cent in parts carrying current. Eighteen per cent of the defects occurred in frames, slabs, coil supports and springs.

Among the direct-current motors examined on account of troubles in operation 39 per cent of the defects occurred in armatures or rotors, 31 per cent in commutators, 15 per cent in magnet coils, 3 per cent in brush rigging and 7 per cent in rotating parts not carrying current. Five per cent of the troubles happened in stationary parts not carrying current. In the case of alternating-current motors examined, rotor troubles were 23 per cent of the whole; slip rings and commutators, 6 per cent; stator coils, 49 per cent; brush rigging, 8 per cent; rotating parts not carrying current, 6 per cent, and stationary parts not carrying current, 8 per cent.

The causes of the generator and motor breakdowns were chiefly dirt, neglect, bad design and poor construction.

Among the specific cases of failure was that of a 250-kw, 500-volt, direct-current generator running at 375 r.p.m. One evening when the load was about 200 amp the watch engineer saw flashing with solder thrown from the commutator lugs. He at once stopped the machine, but found nothing wrong, and it was restarted. A few hours later the sparking recommenced and a second shutdown was made. Careful examination disclosed some solder melted out of four commutator lugs and wedged in behind them a ferrule ⅞ in. in diameter and ½ in. deep, which might have come from the handle of a file or soldering iron. It was apparent that through carelessness the ferrule must have become wedged in place before the connections were all soldered.

The presence of mice in the space between the ends of the winding drum and the commutator lugs of a 500-volt motor

caused a short-circuit and fuse blowing in another case. It appeared that the mice had crawled into the armature during the night to enjoy its warmth and had been flung to the outside of the cavity behind the armature lugs when the motor was started in the morning. As a safeguard against a similar accident the openings in the end plates were covered with a fine wire netting.

The importance of fireproof installations of motors and controlling apparatus in localities where inflammable material surrounds the equipment was illustrated by the case of a 500-volt, three-phase motor driving a hoist in a coal mine. The speed was regulated by a controller of the barrel type immersed in oil, which cut in or out resistance in the rotor circuit. The motor and controller were installed below ground near the doors separating the intake from the discharge air shaft. The room had a wooden floor and was surrounded by fresh coal. On account of a short-circuit in the controller the oil in the box and the resistance cables leading from it were set on fire. The heat was sufficient to vaporize the oil, which set fire to the compartment doors and for a time short-circuited the ventilation of the mine. The sand supplied was useless in smothering a fire on vertical or suspended cables, but the fire was eventually extinguished by chemicals.

Defective bearings caused a long series of troubles with a 440-volt, three-phase motor of 120 hp. The motor was installed to drive drawing machinery by spur gearing, the pinion being 7 in. in diameter and the gear 29 in. The pinion was mounted on the overhanging end of the motor shaft and an auto-starter was provided to reduce the voltage when bringing the equipment into service. The motor refused one morning to speed up, and upon examination one of the auto transformer coils was found to be burned out. In the repair shop the insulation of one of the coils, particularly of the inner section, was found to be roasted and charred, but there were no signs of metallic short-circuits. The inspector concluded that the damage had been done by holding the starting switch on too long when trying to start the motor. In the meantime a starter was borrowed, and later the repaired equipment was put back in service. After some alteration of the taps it was found possible to start the motor with the repaired outfit, on account of the equalization of drop on each phase. Two days later it was found to be impossible to start the motor and the inspector therefore had the triple-pole oil switch taken to pieces and carefully examined, tested the stator and rotor coils and examined all connections. The protecting shields were taken off the sides of the stator and the air gap was gaged and found to be about 1/16 in. wide all around. On applying the current the rotor began to turn slowly and then seemed to be lifted and forced against the upper part on one side of the stator and there to stick. On taking the bushes out of the bearings the upper halves, and especially at the driving ends, were found to be worn sufficiently to allow the shaft and rotor to be forced into contact with the stator by the pressure exerted by the teeth of the driven wheel upon those of the pinion on the end of the rotor shaft. The bearings were adjusted and no further trouble in starting the motor was encountered.

In discussing the accident the insurance company's engineer stated that the reason why the motor started with the borrowed starter, but not with its own probably was that the former delivered a higher voltage than the latter. The reason why it started on some occasions and not on others was more difficult to determine. It appeared that there were some positions of the machinery beyond the driving pinion in which the resistance to motion and consequently the pressure on the pinion teeth was greater than in others. The rotor or stator cores may also have been not quite circular. Whether the rotor was brought to a standstill by friction against the stator core or by loss of torque owing to weakening of the revolving field by the unequal width of the air gap is uncertain, but the occurrence showed that the shields over the stator windings of alternating-current machines should be so arranged by piercing or otherwise that the width of the air gap may be visible. In the case referred to neither the clearances between the shaft and its bearings nor that between the rotor and the stator could be seen without partially dismantling the machine and thus much valuable time was lost in seeking the cause of the trouble.

Another accident occurred in the operation of a 350-hp three-phase motor supplied with 11,000-volt service. The frequency was 50 cycles. The stator winding consisted of double-cotton-covered and braided copper wires distributed in 144 tubes of insulating material carried in as many partly closed slots so that each slot held a tube containing 40 conductors. The winding was divided into 18 coils, six coils per phase, star-connected, so that the voltage between each terminal and the neutral point was 6360 and between each coil 1060 under normal conditions. The rotor was of the wound type with three slip rings and brush rigging for connection to a liquid rheostat for starting. There was no starting apparatus in the stator circuit beyond a three-pole oil-immersed switch without any impedance, inductive or otherwise, between the supply and the motor terminals. Repeated failures of the stator coils occurred, and upon examination of a damaged coil a hint of the trouble was finally found. The cotton covering was bleached, stained green and badly decayed. A test with litmus paper showed it to be acid and further analysis disclosed the fact that nitric acid was present. The conclusion was that the cause of the repeated breakdowns was the destruction of the insulation by nitric acid formed by decomposition of the air by brush discharge from the high-tension conductors.

The reasons why the coils nearest the terminal were most affected were that the difference in potential is highest at such parts of the windings and the brush discharge and formation of nitric acid greatest and also that the concentration of potential, which doubtless broke down the insulation, is bound to occur more or less across the terminal coils at starting. The report states: "Unless brush discharge can be sufficiently reduced, as has been claimed, by restricting the conductors in each slot of the stator to a single row, the only way of preventing damage seems to be to insulate the conductors completely from air and moisture. This may be done by using formed coils thoroughly impregnated and made up solid with waterproof materials before being placed in the slots. Unfortunately this method involves open slots in the stator core, which are detrimental to induction motors, especially small ones, both as regards efficiency and power-factor on the one hand and weight and cost on the other. It has not been found practicable to impregnate windings thoroughly after being placed in position. Adequate protection can, however, be obtained for conductors wound by the 'pin' method by placing them in waterproof tubes projecting beyond the ends of the slots in the stator core and binding the projecting portions and the end windings emerging from them with a thick covering of tape saturated in some adhesive and waterproof material to seal them completely from air and moisture." The owners had the machine rewound for 440-volt service and supplied a step-down transformer instead of following the above plan for protecting the windings.

The report of the year's casualties closes with a warning against touching high-tension machinery or circuits which may have considerable electrostatic capacity even for a time after current has been cut off. Plenty of time should be allowed for the charge to leak away. The stators of large high-tension alternators may remain charged for periods in excess of ten minutes in some cases, and hence the part to be handled should always be given a light preliminary touch with the finger. Long cables armored or buried underground or immersed in water may under certain conditions hold charges for hours and should never be handled by those who do not understand the conditions under which they become condensers and know the proper methods of discharging them.

CONSTRUCTION OF FOUNDATIONS FOR ELECTRICAL MACHINERY.

By Bruce H. Page.

Usually the location of a foundation is determined by the position of the member which is to drive or be driven by the machine that the foundation is to carry. The outline of the

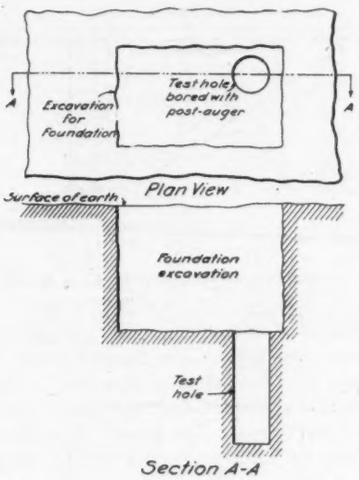


Fig. 1—Method of Digging Test Hole.

foundation plan is, approximately, laid out on the surface, in the designated place, and the hole in which the foundation is to rest is dug. The depth of the excavation is most often such that the base will, if out of doors, lie below frost line, or such that the base will rest on good bottom. Sometimes a

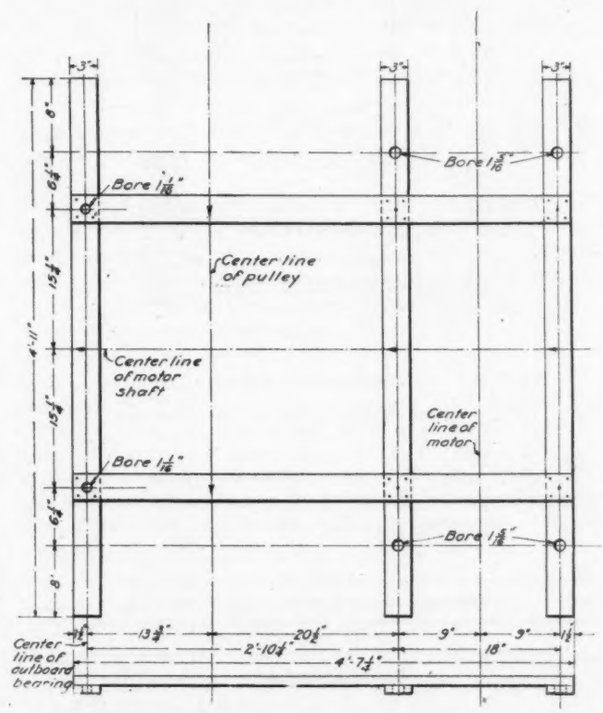


Fig. 2—Foundation Bolt Templet for 110-hp. Motor.

foundation must be made deeper than required by either of these considerations, so that it will have sufficient weight to hold it in position, but not frequently. If it extends below frost line or to good bottom it will, ordinarily, be heavy enough. In a building where frost can have no effect and where the soil is solid the weight may be the determining factor.

As a rule, excavations for adjacent buildings furnish information as to the probable nature of a soil. If there is any question, a test hole, as shown in Fig. 1, can be driven into the soil, from the bottom of the foundation hole, for from 4 ft. to 6 ft. If the soil continues firm for this distance, it is, doubtless, safe to erect a foundation thereon. A test hole can be conveniently made with a post-hole auger, or lacking this, an ordinary spade will do. It is common practice, instead of digging, to explore the earth from the bottom of an excavation with a test-bar. This is merely a steel bar or an iron pipe which is driven with a maul. If such a bar drives firmly and steadily for a distance of, say, 6 ft. into the soil at the bottom of the hole it is reasonably safe to set the foundation on it.

Foundations for machinery should always be entirely independent of other structures. They should in every case be a sufficient distance away from the foundations of the enclosing building that the settlement of one cannot affect the other. For satisfactory operation a driving or driven machine must align accurately with the driven or driving one. This alignment, where foundations are involved, must be secured through the correct location of the foundation bolts. The foundation bolts are held in position by templets during the construction of the foundation, so the templets must be nicely made and located if good operation is expected.

A typical foundation bolt templet of wood is shown in Fig. 2. This illustrates a templet for a 110-hp motor, provided with an outboard bearing, having a speed of 450 r.p.m. The same templet could be also used for a motor of greater rating because manufacturers so design their standard lines of motors that a given frame will accommodate the windings and mechanical parts for motors of two or more horse-power ratings.

Templets are usually constructed of wooden planks, although where its use is justified because of many applications they are built from structural steel. Almost any sort of plank can be used for making a templet, but, because it is cheapest in the long run, reasonably clear-grained pine is used. Yellow pine, although it is heavy, is good. Woods which tend to warp and distort should be avoided. As a rule, the sticks composing a templet are planed on all four sides, but for ordinary rough work this is not necessary. It always pays, unless the templet is a very simple one, to furnish a drawing of it to the erection man with the foundation. From this the carpenter can build the templet without having to search the foundation drawing for his dimensions. The length of each stick and the diameter of all of the holes should be shown so that the workman can obtain at once every dimension that he will require. It is cheaper to record such dimensions on the tracing in the drafting room than to make it necessary for the woodworker to ferret them out for himself. All necessary dimensions are shown in Fig. 2. In this templet the three transverse sticks are made long enough to extend out over the form and support the templet in a manner to be hereinafter described. Important center lines should be scratched on the templet and marked with a *V*, as shown in Fig. 2, because the templet is located with these center lines as index marks.

Templets can be of so many different forms, to accommodate different foundation-bolt arrangements, that it is scarcely feasible to suggest general methods for making them. Obviously they should be composed of the fewest possible number of sticks and weigh little; yet they should be substantial and rigid. The components are held together with wood screws, or, in rough work, with clinch nails. A four-bolt templet and the method of supporting it on the form is shown in Fig. 8.

After the hole is dug for the reception of the foundation and the templet made, the foundation can be built. Stone or brick set in mortar was used much more generally in the past than at present for machine foundations. Concrete has largely replaced both of these materials except for temporary work.

For this and in certain other cases brick and mortar foundations find convenient applications. Lime mortar is most often used. There are certain small foundations which are to be permanent that can be built more cheaply of brick than of concrete. This is because of the cost of the forms necessary

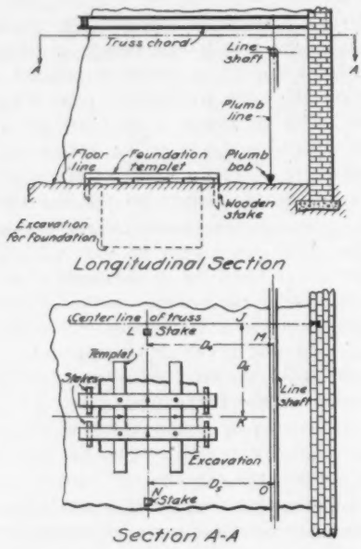


Fig. 3—Lining Templet to Line Shaft.

for the concrete foundations and of the fact that a brick mason and a laborer can build a brick foundation without having to secure aid from the carpenter shop.

A mixture of one part cement, three parts sand and six parts gravel forms a concrete that is extensively used and that has

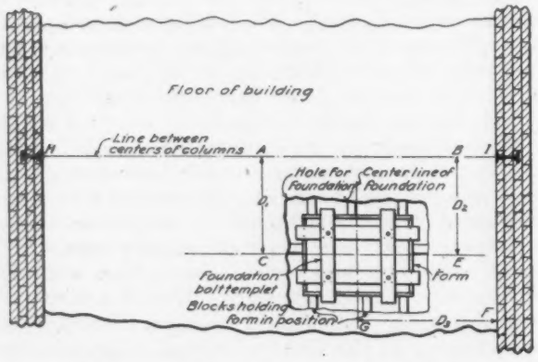


Fig. 4—Lining Foundation to Truss Centers.

given perfect satisfaction for machine foundations. This mixture will weigh, when set, from 140 lb. to 150 lb. per cubic foot. In general, concrete foundations only will be discussed in this paper. Much of the information given concerning them applies to masonry foundations.

Ordinarily, a form is required for a concrete foundation. There is, in books and articles on concrete construction, an abundance of information regarding the building of forms. Although these do not specifically treat of machine foundation forms, their suggestions are, generally, applicable. All that practice sanctions in regard to timber for and the construction of and the bracing of forms for other structures can profitably be reviewed by the machine foundation constructor. Forms will not be treated of further with the exception that a few suggestions will be given in this article.

Two typical cases, illustrating how templets and forms are located, are shown in Figs. 3 and 4. In Fig. 3 a foundation to carry a motor to drive a line shaft is being installed. The foundation center lines are located from the dimensions D_4 and D_6, given on the erection drawing. These are, respectively, the distances from the center line of the line shaft and from the center line of an adjacent truss to the foundation center

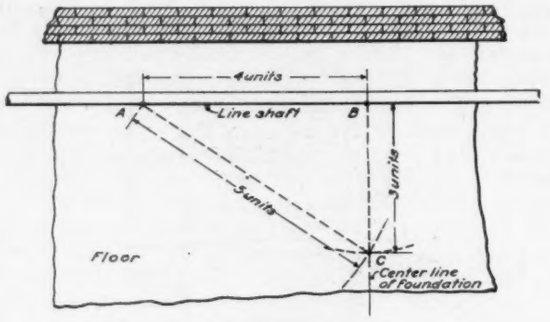


Fig. 5—Method of Aligning to Line Shaft.

lines. The soil is so firm that no form is required. The excavation constitutes the form. The templet, after having been accurately aligned, in a manner to be described, is held in position by being nailed to wooden stakes driven in the soil.

The aligning is done thus: The plumb-bob dropped over the line shaft indicates the location of that member on the surface

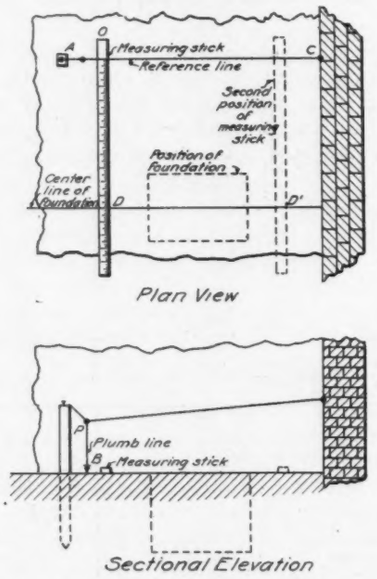


Fig. 6—Method of Aligning to Truss Centers.

of the soil. The plumb-bob is first adjusted at the point M and the distance LM measured off and then at O and the distance ON measured off. The string LN, representing one

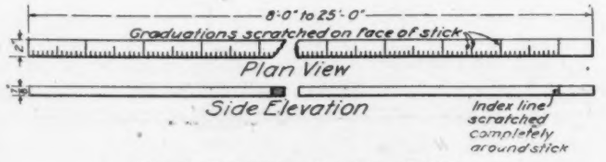


Fig. 7—Measuring Rod for Aligning.

center line of the foundation, is drawn between two stakes. The templet is now adjusted until the two corresponding index lines on it coincide with the string line. Then the templet is shifted until the distance JK is correct and it is nailed to the

stakes which have previously been driven at approximate locations. The elevation of the templet is determined from the floor line without difficulty, and it is adjusted until it (the templet) is level in all directions. The sticks composing the templet have been left long enough to extend beyond the excavation so that they may be nailed to the stakes.

In Fig. 4 is shown a templet which is being aligned from a truss center line. In this case a form is used and the templet is nailed to the top edge of the form. The longitudinal center

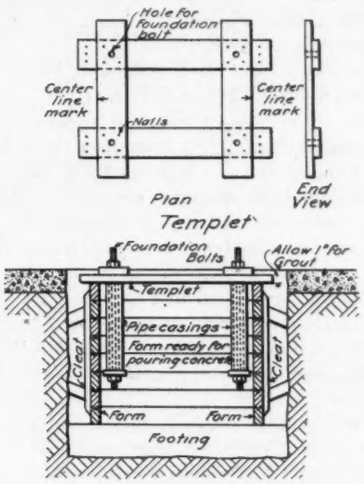


Fig. 8—Templet and Form in Position.

line of the foundation *CE* is made parallel with the truss center line *HI* through the measurements *AC* and *BE*. The distance *GF* is from the inner face of the wall to the transverse center line. All three of these center lines (*HI*, *CE* and *GJ*) are, in practice, taut cords. After the templet and form have been accurately located in their correct position, blocks are wedged between the outer face of the form and the face of the excavation to prevent the form from shifting while the concrete is being rammed in. Sometimes, if the form is not worth saving, the space between the form and the foundation is filled with earth before the concrete is placed and the form is left there.

It is essential that measurement lines, such as *ML*, Fig. 3, and *AC*, Fig. 4, be at right angles to the reference line from which the measurement is taken. If one is available these right angles are best determined with an engineer's transit, but if no instrument is at hand they can be accurately laid out by one of the methods suggested in Figs. 5 and 6. In Fig. 5 an application of the law of a right triangle is used. It is desired to lay off the line *BC* at right angles to the line shaft. A plumb-bob is dropped at *B* over the line shaft and the point marked. At *A*, which is located so as to be four units distant from *B*, the bob is again dropped. Then with radii of respectively five units and three units arcs are struck from *A* and *B*, which intersect at *C*. Then the line *BC* through *C* will be at right angles to the shaft. The radii are struck with a piece of string having nails tied on for points at each end.

A measuring rod, shown in Fig. 7, is used for laying out the lines accurately in Fig. 6. The measuring stick is merely a clear-grained piece of white pine, say, 2 in. wide and from 8 ft. to 25 ft. in length, of ⅞-in. stock. It should be nicely planed on all four faces and have an index line and graduation lines scratched on it. The index line is "squared" around all four faces, while the graduations appear on the upper face only and usually divide the stick into feet and inches. It is essential that the stick be not narrower than 2 in. When it is used for laying out one line parallel to another, the reference line (a string) lies over and when the stick is at right angles coincides with the index line on the stick. If the stick be too narrow, the reference line may seem to coincide accurately with the index line when it does not. The wider the stick is the greater will be the accuracy.

A reference line *AC* (Fig. 6) is strung. It may be between two column centers or between a stake and some other point. A plumb-bob *B* is hung at a convenient location from the reference line. The measuring stick is then laid on the ground in the position shown in Fig. 6 and its outer end is shifted around *O* as a center until, to a person sighting with one eye from a position at *P*, the index line (on the measuring stick) the plumb line and the reference line all coincide. The stick is then at right angles to the reference line. A mark is made on the floor at *D* the required distance from the reference line. This operation is repeated with the stick in the position shown in dotted lines and the point *D'* is obtained. Then a line through *D* and *D'* is parallel to the reference line and at the correct distance from it. The templet is located with reference to this line.

BOILER-ROOM PRACTICE DISCUSSION AT MICHIGAN CONVENTION.

A paper on the boiler-room and its contents was given by Mr. H. F. Rosenkrans at the recent Michigan Electric Association convention. He first pointed out that it is sometimes well to have boiler tests made by experts, so that changes can be recommended that will increase the efficiency of the plant. The engineer who says, "What is the use of going to so much trouble?" is usually a man who does not read the engineering papers or keep posted, and is of the kind who never get ahead. The boiler-room should be considered first in the operation of any steam plant. It is often considered last. The author described the bad effect of uneven firing, with hot fires one interval and a general cooling off of the fire brick and tubes another interval by having the doors open too much and throwing on large quantities of coal at a time. The efficiency of a boiler is not all in the boiler. It is often in the way it is operated. Some firemen with the same fuel will increase the efficiency from 10 to 30 per cent.

As to specifications for new boilers, the boiler must be designed for a working pressure to suit the conditions, using a factor of safety of five on riveted joints. The material and workmanship must be the best quality throughout. All riveting, calking and expanding must be done carefully and thoroughly. The boiler must be tight under a water pressure 50 per cent over the designated steam pressure. The steel should be open-hearth and stamped with the maker's name and tensile strength. It should have an ultimate tensile strength of not more than 65,000 lb., or less than 58,000 lb. per square inch., and an elastic limit of not less than one-half of the ultimate tensile strength. The elongation must not be less than 25 per cent in 8 in., and the reduction in area not less than 50 per cent. The sample must bend back on itself cold, without sign of fracture under cold and quench tests. Usually these tests are made at the mills where the boiler steel is manufactured. The report of these tests should be accompanied by an affidavit that the report is that of tests of specimens from the mills from which the plates are rolled. The heating surface of tubes should be figured on the fire side only, and such heating surface should be 9.5 sq. ft. per horse-power. No other parts of the boiler should be allowed as heating surface. A boiler should carry continually, if necessary, 33 per cent more work than it is rated to carry without any undue strain to boiler or setting; the steam should not show more than 2 per cent moisture at the nozzle; and the boiler should evaporate 10 lb. or 11 lb. of water per pound of coal, from and at 212 deg. Fahr., with coal of 14,000 heat units per pound. The steam nozzles should be of cast steel and riveted on. The blow-off opening should be of cast steel or boiler plate riveted on, giving ample surface for screw-

ing in pipes. Any opening over 2 in. should have flanges riveted on.

The steam piping should be as short as possible. Many plants have the boiler-room at one end of a large building, and the main steam pipe running the whole length of the boiler-room and engine-room, when the boiler-room could have been directly back of the engine-room, thus saving about half of the pipe. Double-strength fittings should be employed where pressures are over 125 lb. Long-sweep bends should be used in pipes where possible, and especially from the main steam nozzle of the boilers to the main steam pipes. The steam pipes should be drained by inclining them toward the engines, and the drip connection should be just above the throttle of the engine. This prevents a possibility of water hammer or bursting of steam pipes. All steam pipes should be covered with a good air cell or 85 per cent magnesia covering, and after the pipes are covered flour paste, consisting of about 2 lb. of glue to 5 gal. of paste, should be applied. Two or three coats of this will keep out air, and the pipes will be better looking and more easily kept clean.

A poor feed-water pumping system is a constant worry to the boiler attendant, and endangers life and property. Should the water in the boiler become dangerously low, it is not always necessary to draw out the fire. If ashes are available they can be moistened with water and thrown over the fire. This deadens the heat at once. After the boiler furnace and parts of the boiler exposed to heat are properly cooled, the boiler can be filled with safety, and the ashes can be pulled off the hot coals and the fire started. The boiler feed pump should be as close to its work as possible, to avoid long runs of piping. The feed pipes to the boilers should always be double-strength pipes, and made perfectly tight with a good plug valve, like a blow-off plug valve for shutting water off. This should go next to the boiler. Outside of this should be a swinging check valve. A union next to the check valve and one next to the feed pumps allow easy and quick repairs. A union should never be placed between the boiler and shut-off valve on a feed line. If possible globe valves on a feed line should be avoided, but if they must be used they should be so connected that the water goes against the bottom of the valve and passes up through the valve and then to the boiler. Should the valve come off the stem, it does not shut off the boiler feed, as it would if put in the other way.

The open heater and purifier is perhaps the best source of hot water. With exhaust steam, especially if at from 1 lb. to 5 lb. back pressure, a feed temperature of 214 deg. to 220 deg. is obtained, but if a back pressure is carried on the heater, there should be from 3-ft. to 5-ft. head from the heater to the boiler feed pump. The open heater and purifier is also good for a compound condensing plant, by taking hot water from the hot well for the heater and heating it with live steam with about 5 lb. back pressure on the heater. When doing this all exhaust openings should be closed to prevent waste of steam. This will give a feed temperature of from 210 deg. to 220 deg. If there is no gain in heat by this method, there is a gain by feeding pure water to the boilers, keeping the boilers cleaner and in better condition than if water were fed in from the hot well at 100 deg. There should be a set time for cleaning boilers at regular intervals. A boiler should never be cooled by blowing it down and then filling it with cold water. This will cause leaking tubes sooner or later. It is good to blow off a boiler vigorously once or twice in twenty-four hours when steam is high and the load light. The blow-off valve should not be opened with a jerk, but opened and closed slowly to prevent water hammer. If a plug blow-off valve is used the plug should be removed occasionally and painted with graphite and cylinder oil, which will make it stay tight longer and make it open more freely.

In changing over from one boiler to another the pressure on each boiler must be alike, as there is danger when the pressure is unequal. The valve should be opened slowly and if a rush of steam is heard in the pipe line, the valve should be left cracked until the pressure becomes equal, when it may be opened wide. It is well not to cut out the other boiler until the one cut in has been under steam an hour or two and warmed up. The fire should burn out clean in the boiler which is being cut out, to keep it from popping and blowing steam after being cut out. It is well to have a steam vent pipe at the highest point in the steam dome to let the air out when filling, and after cleaning this should be left open until the steam rises to allow the air to escape so as not to interfere with the speed of the engine when changing over boilers. A man may be judged by the appearance of his boiler and boiler-room. A clean, neat boiler-room usually signifies a clean, wide-awake engineer and superintendent in charge.

Mr. H. A. Chase, of Hart, followed with a written discussion on this subject. He thought that the art of firing must be self-taught. The firemen learns by experience best what is the most economical way. At Hart it is his custom to weigh all the coal brought in and the ashes taken out, and to keep a record of the kw-hour output. He recently visited a plant where there were holes in the breeching of the boiler and around the fire doors and the arch had fallen in so as to let some of the gases go directly up the chimney. On questioning the engineer about it, he said that he could not see any difference in the fuel consumption since the arch had fallen in, so he did not think it worth while to repair it. Such men, Mr. Chase thought, should be carrying a hod instead of running a boiler-room.

Mr. A. N. Richardson, of Ann Arbor, in answer to a question as to the use of fuel oil by his plant, said that oil fuel is used only for peak load. Water-power supplies most of the output. For operating a peak-load plant this fuel oil is very satisfactory and takes much of the labor out of the boiler-room. For ordinary twenty-four hour runs, however, it has been established that fuel oil cannot compete in Michigan with coal at present prices. Mr. Chase remarked that forcing a boiler is likely to increase the cost of the output. Mr. J. R. Cravath, of Chicago, said that in many of the larger plants it is now the practice to overload boilers for short periods, rather than start up additional boilers, and that boilers have been found economical at much higher rates of working than were formerly considered proper. In small plants there is fequently a tendency to run more boilers than necessary during a light-load period. While this makes matters easy for the fireman, because he does not have to pay as much attention to keeping up steam as he would if the boilers were working hard, it is likely to be detrimental to economy. If a boiler is being worked fairly hard, the fireman has to use his fuel with some degree of economy in order to keep up steam.

Mr. A. C. Marshall, of Port Huron, thought this a good point for investigation by small plants, as the larger plants have been working boilers at higher capacities recently.

Mr. John Cavanaugh, of Benton Harbor, suggested that if the fireman gets lazy, so that he does not keep even fires, the remedy is to get a new fireman. Boilers, he said, are sometimes overrated.

Mr. A. N. Richardson claimed that before a boiler can be overloaded it must be provided with a furnace which can stand the heat. Frequently the furnace limits the load.

Mr. R. W. Hemphill, of Ann Arbor, called attention to the fact that the practice of the larger coal consumers at the present time in buying coal on a heat-unit basis has caused the coal which is high in heat units to be shipped to these larger users. The result of this is likely to be that the smaller companies get the poorer coal, which the coal companies cannot supply with profit to the large companies under test. Therefore, there is an increased necessity for small users to be more careful in purchasing coal. He thought it would be well for the executive committee to make an arrangement with some laboratory for members to procure coal analysis at intervals. Mr. F. B. Spencer, of Cheboygan, said that a large number of tests made by the University of Michigan laboratory might be available for the information of members on various fuels.

LETTERS ON PRACTICAL SUBJECTS

A PORTABLE STAND FOR GRAPHIC INSTRUMENTS.

Graphic, or, as they are sometimes called, curve-drawing, electrical meters are very useful to concerns that employ many motors in that with a graphic instrument a permanent accurate record of motor performance can be obtained. The curve, usually reading in either amperes or watts, indicates clearly what the average, maximum and minimum inputs to the motor are and it shows the time relations between them. It is impracticable to obtain significant records of these characteristics through the use of indicating instruments. In a reasonably

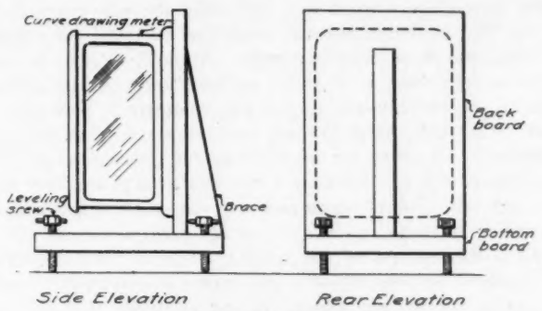


Fig. 1—Stand for Graphic Meter.

large concern a graphic instrument will usually pay for itself the first year it is used by enabling its purchaser to select motors of the smallest capacity that will do the work.

When a motor drive for a new machine or application having unknown input characteristics is being arranged a spare motor should be geared to it temporarily. The input to the motor should be measured and recorded with a graphic instrument. From the curve thus obtained it will be possible to determine to a certainty the size of motor that should be purchased. There need be no margin allowed so that the motor may be quite big enough. If necessary a curve-drawing instrument can be inserted in the motor circuit and be left there for a day or a week or a month, and it will, with little attention, accurately

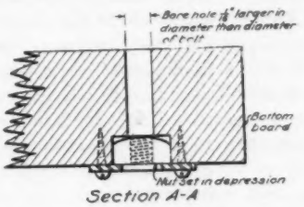


Fig. 2—Detail of Leveling Screw.

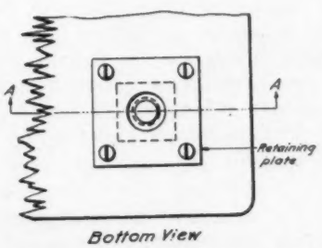


Fig. 3—Arrangement for Leveling Screw Nut.

record what the input requirements to the motor have been for each interval of time during the period.

Obviously, for such functions a graphic meter must be portable. It must be so arranged that it can be easily transported to and set up at any point in the plant. The better types of curve-drawing instruments have been designed for switchboard mounting, so that if they are to be made portable a special stand must be arranged for them. Fig. 1 shows a type of stand that is easy to make and cheap, and which will give good service.

Referring to Fig. 1: The stand is composed of three pieces of board about 1½ in. thick. The actual thickness of the back board is determined by the thickness of the switchboard panel for which the studs and supporting bolts on the instrument are designed. Thoroughly dried wood should be chosen for the support and a wood that will not warp readily is much to be preferred. The component pieces are held together with screws and they can be mortised one into the other if desired. After assembling, the whole should be well varnished to prevent any possibility of warping. The sizes of the component pieces of board and the locations of the stud and bolt holes depend on the make of meter that is to be mounted. The manufacturer of the instrument will furnish a drilling templet and an outline drawing of it, but it is probably better to take dimensions from the instrument after it has been received.

Four leveling screws, one in each corner, are arranged in the bottom board. A meter of this type must be quite accurately leveled if a true record is expected. The leveling screws are constructed as delineated in Figs. 2 and 3. The screw itself, Fig. 2, is made by inserting a slightly tapered pin through a hole drilled through the head of a hexagonal head tap-bolt of about ⅜ in. diameter. The pin, which serves as a handle, is formed from drill or brass rod. It is driven snugly into the hole and, because of its taper, will stay there.

The nuts through which the leveling screws turn are arranged as detailed in Fig. 3. A square iron nut is tightly fitted into a depression cut in the bottom of the bottom board, and a metal plate, fastened over it with wood screws, retains it. The round hole through the board for the leveling screw should be bored somewhat larger than the diameter of the screw so that there will be ample clearance.

Directions for the arrangement of electrical connections cannot be given because they are different for each make of instrument. For direct-current installations, where the voltage regulation is reasonably good, a graphic ammeter will draw curves which, by taking into account the voltage (which is assumed to be constant), can be calibrated in watts or horsepower. An ammeter is simpler than a watt-meter, is more easily connected and is, on the whole, preferable for direct-current work. But in alternating-current work, where low power factors are encountered and where the current taken by a motor may not be at all proportional to the actual power consumed, a wattmeter must be used.

One graphic instrument can be made to record inputs to motors of small, large or intermediate capacities and of different voltages by providing suitable shunts and multipliers for direct-current instruments and series and shunt transformers for alternating-current instruments. The electrical manufacturers do not regularly list these "wide range" outfits, but will furnish information concerning them on application.

Pittsburgh, Pa. H. H. Kenney.

CHANGING OVER FROM 220-VOLT DIRECT CURRENT TO 110-VOLT ALTERNATING CURRENT.

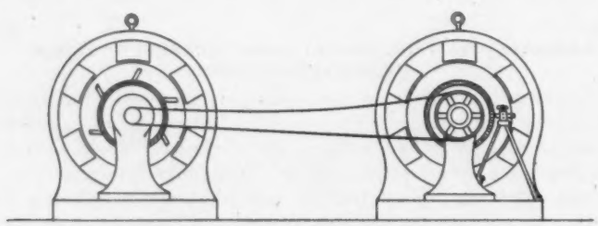
About fifteen years ago it was the practice to install 220-volt direct-current systems for commercial lighting in the smaller towns. Since that time most of the towns have outgrown the limitations of the system, and as a consequence regulation is inconceivably bad, line losses are exorbitant, and the plants are either on a losing basis or very near it. In many instances the managements would very gladly spend the necessary money to change to alternating current, but they are possessed with the idea that the change would involve so many difficulties, interruptions of service, and inconveniences to consumers that the advantage of the change would be more than overbalanced by disadvantages. Such managements, however, are crossing bridges before reaching them, judging from the experiences at Lawrenceville, Ill. This plant had a load of about 40 kw on 220-volt direct-current circuits. Street lamps were connected in multiple between one of the regular service wires and a third wire which ran back to a switch in the plant. The

first step toward making the change was to install the alternating-current plant with separate engine, switchboard, feeders to the central distributing point on the public square, and two transformers with a total capacity of 30 kw located near this central point. With the equipment installed all that was necessary to change to alternating current was to cut in the transformers and start the alternator, leaving the switches on the direct-current board open. Transformers were tapped across the 220-volt wires and the service on these was continued without interruption. To facilitate establishing 110-volt service the incandescent street lamps were connected permanently across the commercial 220-volt mains and the third wire was connected into the transformers and made to serve as a neutral. All new services were connected to the neutral and were supplied at 110 volts. The management was very anxious to get the old service over to 110 volts, but at the same time did not care to bear the entire expense of the new lamps required in the change. It was finally decided to give a credit of 12½ cents for all old 220-volt lamps, to apply on the purchase of new lamps, on which the company made a profit of 5 cents. To induce consumers to make the change the higher efficiency of 110-volt Gem and tungsten lamps and the fact that flatirons fans and other devices could be connected to 110-volt circuits and not on the 220-volt lines were widely advertised. Eighteen months after alternating-current service was established there was only one 220-volt lighting service. In this instance, at only a very nominal expense to the company for lamps, the change was made without causing a single interruption of service and without forcing any customer to any expense for lamps against his will. The company, of course, went to considerable expense in purchasing new meters. However, all the old meters were sold for $5 apiece, and the revenue from these was equal to almost half the cost of the new ones.

Lawrenceville, Ill. CALE GOUGH.

TURNING DOWN A COMMUTATOR

There has been so much published about the care of commutators that it would seem difficult to write anything more on the subject. However, the following scheme may be new to some and has been used in a number of instances with very satisfactory results. The method usually used to turn down a commutator on a repair job where the armature is too large to remove is to leave one or two pairs of brush arms on and run the machine from these at as low a speed as the field regulation will permit, or possibly with a water rheostat in the armature circuit. This will, of course, do where nothing else is possible, but there is always bad sparking and burning at the point of the cutting tool due to its short-circuiting the bars when it crosses the mica. The tool has to be sharpened frequently and the job is seldom good even where the greatest care is exercised. For this reason it is always best to belt the



Belted Units.

machine to a separate motor and turn down the commutator with the fields unexcited. In the plant with which the writer is connected there are several machines set symmetrically with their shafts parallel. The shafts overhang the outside of the bearings sufficiently to enable one to put a pulley on the shaft of the machine to be repaired. The belt is then put directly on the shaft of the other machine and by using a suitable pulley the proper speed for turning down is obtained. A commutator 20 in. or slightly more in diameter can be run at about 75 r.p.m. with good results, but it is better to keep below this speed than to exceed it. The accompanying sketch shows very plainly the scheme indicated above; it is unnecessary, of course, to shut down the machine used as the motor and the additional load would seldom, if ever, be of serious moment.

Niagara Falls, N. Y. J. CLOYD DOWNS.

DEALING WITH NATURAL GAS COMPANIES

Electricity usually gets the better of it in a fight with natural gas, but while the strife is going on a great deal of anxiety is caused by the management of the lighting company and much time is wasted because the electric light company does not impress upon the gas company some forcible reasons why it should not push the use of gas for lighting. The arguments are effective only in case the electric light company employs the gas company's product in the generation of electricity. In short, it may be argued that indirectly the gas company can get at least as much revenue from the electric light company as from customers using gas lamps. An 80-cp Welsbach burner will consume about 4 cu. ft. of gas per hour. At 20 cents per 1000 cu. ft. the revenue to the gas company is 0.08 cent per hour. The fuel cost at 10 cents per 1000 cu. ft. with gas under a boiler is 1.5 cents per kw-hour in the average small plant. This brings the gas company a revenue of 0.36 cent per 80 cp per hour with 3-watt lamps and 0.15 cent with tungsten lamps. According to these figures the gas company will come out far ahead if it stays out of the lighting business. But the figures are changed considerably if a gas engine is employed. Assuming gas at 20 cents per 1000 cu. ft. and an engine that will average 15 cu. ft. per hp-hour, or 20 cu. ft. per kw-hour, the revenue to the gas company is 0.4 cent per kw-hour, or 0.1 cent and 0.024 cent per 80 cp per hour with carbon and tungsten lamps respectively. The percentage of carbon and tungsten lamps usually found on an electric system would probably bring the average up to 0.08 cent, the revenue to the gas company when the gas is employed directly in lighting. The gas company may argue that the Welsbach mantle is not always in good condition (and usually it is not) and as a consequence consumption is so far beyond 4 cu. ft. per hour that the actual revenue is much greater than indicated by the figures given. This is doubtless true, but the increase is certainly offset by the fact that during the winter months gas is used for heat as well as light, and that the consumption in the stores is decreased by an amount equal to that of the gas used for lighting. In other words, the revenue to the gas company would be as great during almost half the year were no gas employed for lighting. Where a minimum bill is charged the revenue during the warmer months is likewise not increased as much as would at first be presumed. There are usually four months when at 20 cents per 1000 cu. ft. the gas consumption of the average family for both cooking and lighting is not up to the minimum charge, and in such instances the gas company gets no revenue from the gas used for lighting. Taking it all in all, if the electric light company will burn gas at its plant the gas company can safely discourage gas lighting. On the other hand, where gas competition cuts into the revenue seriously it would probably pay the electric company to go to some additional fuel expense if necessary and use gas as fuel if by so doing the gas company could be induced to get out of the lighting business.

Chicago, Ill. GEORGE HOEHN.

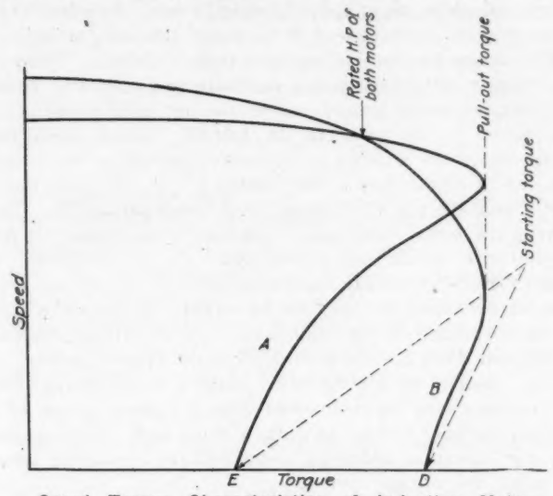
STARTING TORQUE OF INDUCTION MOTORS.

In your first issue of July appeared an article by Mr. Southworth on the starting torque of induction motors which contains a very practical way of determining the starting torque of any kind of a machine, line shafting, etc. However, in the application of the data difficulty is experienced in distinguishing between torque and horse-power.

For instance, in the example quoted, the author finds that a 60-lb. pull is necessary to start the line shafting. He then uses this starting torque for the calculation of the horsepower necessary at the rated speed of the shaft, apparently

forgetting that the 60-lb. pull was registered at practically zero speed. Aside from the confusion of mechanics involved, it is, of course, impossible to pick out the size of the motor necessary to start a given load without some consideration of the operating characteristics of the motor.

It cannot be assumed offhand that the starting torque of every induction motor bears a fixed relation to either the full-load running torque or the pull-out torque. For instance, the 5-hp motor which Mr. Southworth believes necessary to run the load might have a speed-torque characteristic represented by either of the curves A and B of the accompanying illustration. The shape of these curves, of course, depends upon the resistance in the motor. These two motors might have the same full-load running torque and also the same pull-out torque. However, the starting torque of B is twice as large as that of A, as shown by the two points *D* and *E*, of the torque curve at zero speed.



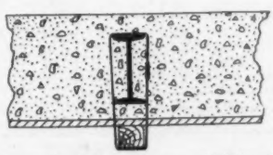
Speed Torque Characteristics of Induction Motor.

Any reliable motor manufacturer is willing to supply the speed-torque characteristic of a motor, so that in case it is necessary to calculate the size of motor to start a given load it would be necessary merely to use the suggestion which Mr. Southworth gives and obtain the pounds pull reduced to a 1-ft. radius; then if the motor selected shows the point *D* to be equal to, or greater than, the starting torque calculated the motor is of ample size to start the load.

New York. GEO. F. FENNO.

SUPPORTING CONCRETE FLOOR FORMS WITHOUT SCAFFOLDING.

In building the concrete floor of a large power station in Illinois on which I was recently employed we erected all the forms in position and placed the concrete without constructing any supporting scaffolding to carry the forms while the concrete was being poured or was setting. In this case the forms were supported by wire loops slung over the steel beams, the wire being cast into the concrete as the latter hardened and having its protruding ends snipped off flush with the lower surface of the finished floor slab. The accompanying sketch shows how this was accomplished, and illustrates the great saving of labor which resulted from avoiding the erection of supporting scaffolding. After the concrete had hardened the wire loops were cut off close to the finished surfaces, and as this floor formed the basement ceiling these few protruding ends did not prove objectionable in appearance.



Supporting Concrete Floor Forms Without Scaffolding.

Chicago, Ill. MORTIMER MEEKS.

110-VOLT SHUNT MOTOR ON A 220-VOLT, THREE-WIRE CIRCUIT.

A friend of mine recently called me into his shop to ask my advice about the cost of having his 2-hp, 110-volt shunt motor rewound for 220 volts, as the central-station company refused to allow him to continue operating this machine across only one side of its Edison three-wire system, claiming that its operation tended to unbalance the lines. The cost of reconstruction as estimated by a local electrical company really exceeded the second-hand value of the motor, which was an old one; and as the service it rendered was only occasional and at low speeds, such a change did not seem worth while. After examining the case, the thought occurred to me that at the low speeds commonly employed (control being secured by manipulating the starting rheostat in the armature circuit) the current taken by the armature probably would not much exceed that taken by the field, and the two might be accordingly connected in series across the 110-220-volt, three-wire system with the neutral tapped in without much unbalancing. I tried this, first taking the precaution of reversing the armature brush leads to secure the same direction of motor rotation. The motor started up as usual, and at none of the loads it was called upon to pull did the armature circuit take current exceeding that of the field winding by more than the demand of a 32-cp carbon-filament lamp. When this fact was shown to the company's inspector he of course, was satisfied, as the unbalancing now produced by the motor did not exceed the effect of turning on a single lamp. That 110-volt motor is accordingly now running with its armature and field virtually in series across 220 volts, the neutral being connected in to carry the difference in demand of the two windings, and the expense of rebuilding it has been avoided by a few simple changes in connections.

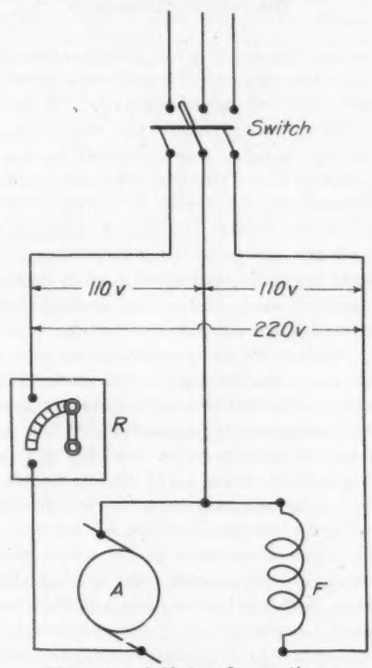


Diagram of Motor Connections.

Kalamazoo, Mich. JOHN BURNS.

PARALLELING SMALL COMPENSATED COMPOUND-WOUND ALTERNATORS.

In many plants where operation would be greatly facilitated by paralleling alternators with compensating windings the machines are kept independent because of the inability to hold them in parallel without undue hunting. Frequently the engineer gives up the job after a few attempts, and submits ever afterward to the inconveniences attendant upon running the machines separately. It sometimes happens that the designs of the machines make it almost impossible to run them together, particularly when the machines have compensating windings.

If the machines are of the compensated types efforts to parallel them should not be given up until trial has been made with these windings cut out. An instance within the writer's experience may be cited. Operation of two alternators together was given up after a few unsuccessful attempts and switches were arranged to give each machine a separate load. Later, increased output made parallel operation imperative. An attempt with the compensating windings of each machine cut out proved entirely successful from a paralleling standpoint, but voltage could not be maintained on the smaller dynamo without current in the compensating winding, and when operated

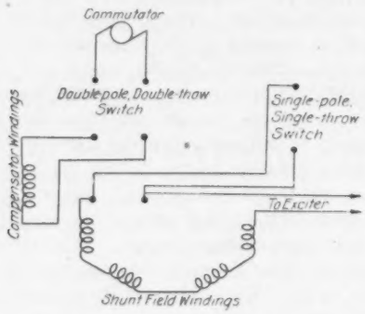


Diagram of Connections.

single the voltage fluctuated to a disagreeable extent on this machine. All difficulties were finally overcome in the following manner: On the larger machine, a 75-kw Wood alternator, driven by a steam engine, the rectifying bushes were lifted and the commutator short-circuited by binding No. 11 copper wire around it. The disconnected compensating coils were then permanently connected in series with the smaller field windings in the exciter circuit. The smaller machine, a 50-kw Westinghouse, driven by a three-cylinder gas engine, had its compensating winding excited through a commutator from transformer secondaries wound on the spokes of the armature. To obtain the additional excitation resulting from putting the compensating winding in the exciter circuit and to facilitate changing from compound to plain shunt excitation double-pole and single-pole, double-throw switches were connected, as indicated in the accompanying engraving. When both switches were thrown up the compensating winding was connected direct to the commutator bushes. With the double-pole switch down and the single-pole switch open the two fields were in series on the exciter circuit. It was, of course, necessary to keep the shunt field circuit closed, and this required that the single-pole switch be not opened until the double-pole switch had made contact with the lower posts, and that the single-pole switch be closed before throwing the double-pole switch upward. In practice it was found necessary to lift the compensating bushes in order to eliminate excessive sparking with circuit open. The machines were successfully operated in this manner for about twelve months.

Helena, Mont. Richard Schultz.

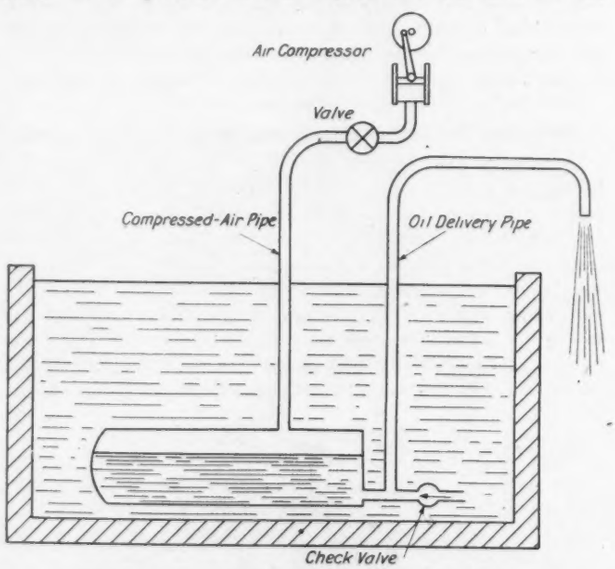
HOUSE LIGHTING FROM PORTABLE STORAGE BATTERIES.

The introduction of the portable storage battery and the miniature tungsten lamp for automobile lighting has directed attention to many other uses for which these small self-contained power plants are adapted. Low-voltage tungsten lamps are now found on 75 per cent of the automobiles in use, deriving their energy supply from a small portable battery, usually of the type known as "6-60," which signifies a 6-volt, 60-amp-hour battery. A unique electrically equipped home is that of Mr. J. A. Haschke, on the West Side, Chicago, in which all of the lighting is done from low-voltage tungsten lamps supplied from two portable Jewel storage batteries of the type mentioned above. One of these batteries, mounted on a shelf in the basement, is connected to fourteen 6-volt tungsten lamps of various sizes from 2 cp to 10 cp. Five of these lamps, enclosed in oval reflectors, are mounted in clothes closets, being so wired to burglar-alarm contacts that they are automatically lighted when one enters. Lamps are also arranged about the various dressing mirrors in the rooms and 8-cp lamps are provided to furnish the general illumination of the bedrooms. A 6-cp lamp lights the music sheet on the piano, and in the basement is a 10-cp lamp over the coal pile, which is useful when the furnace is to be fired. The battery is also connected to a jump-spark coil which ignites the burners of the kitchen gas stove and supplies energy for operating a system of burglar alarms, call bells, electric door chimes, electric fans and cigar lighters. The other battery is used for operating a vacuum cleaner, a sewing-machine and a massage vibrator. There is now being constructed for this residence an electrically lighted and operated water-spray fountain for the parlor, which will also derive its energy from the battery. About every two weeks one of the batteries is taken downtown to be re-charged. The cost of re-charging a 6-60 battery is only 15 cents, therefore making the cost of up-keep but 30 cents per month. Considering the many conveniences obtained from these batteries this low cost seems very economical. As the installation is classed under low-voltage apparatus, the cost of running lines to additional lamps and, in fact, the whole illumination scheme has been reduced to the minimum. Special fittings required for 110-volt work are not needed for these battery circuits. It is also found to be convenient to install a 6-volt storage battery in series with the commercial-voltage lighting system of a nearby residence, thereby securing a dependable source of energy for operating doorbells, stove lighters, miniature lamps and other low-voltage devices.

Chicago, Ill. Thomas Johnston.

DELIVERING OIL FROM OPEN TANK BY AIR PRESSURE.

A letter in the September issue on the subject of moving oil by air pressure reminds me of an application of this same principle which has been in use for transferring oil from a large roofed tank in a Pittsburgh electrical manufacturing plant for several years. The enclosed sketch shows how the device operates, the submerged tank being nothing else than a familiar kitchen hot-water boiler in one inlet of which an inwardly opening check valve is inserted; the other pipes leading from the air compressor and to the oil delivery lines, respectively, as indicated. When there is no pressure on the air line the oil enters the tank through the check valve until the tank is filled. If air pressure is then turned into the tank the oil,



Forcing Oil from Open Tank by Compressed Air.

which cannot escape through the closed check valve, is forced out through the delivery pipe. After the oil contents have been forced from the tank, the air pressure is again released by opening the air line to the atmosphere and the tank quickly fills with oil again through the check valve.

Pittsburgh, Pa. J. P. Freyertag.

QUESTIONS AND ANSWERS

What relation does the horse-power required to drive a direct-connected exhaust fan bear to the speed of the fan? G. L. H.

The volume of air delivered by a centrifugal fan varies directly with the speed of rotation. The pressure exerted by the fan varies with the square of the rotative speed. The power necessary to drive the fan, therefore, varies with the cube of the speed. The above relations are theoretical, but correspond with a fair degree of accuracy to the results actually obtained in practice.

How can the speed of a 110-volt, single-phase, four-pole motor be increased from about 700 r.p.m. to about 1500 r.p.m.?

Although you have not stated the fact directly, we are led to believe that the single-phase motor mentioned in your query is of the induction type. In order for a four-pole motor to operate at 700 r.p.m. it would be necessary to supply the machine with 25-cycle current. When rewound to make a two-pole motor the speed would reach probably 1400 r.p.m. at full load.

What would be the effect of taking out and turning end for end the squirrel-cage rotor of a three-phase induction motor? S. R. N.

When the rotor of an induction motor is taken from the machine and replaced with its ends interchanged the operation should not be affected in any respect, provided only that all bearings of the machine are symmetrically placed with reference to the center of the rotor. That is to say, the rotor should align accurately with the stator core. Unless this condition obtains there will be a considerable magnetic pull on the rotor, the tendency being for one of the bearings to become overheated.

Kindly give a short, simple method of finding the number of amperes per terminal of a three-phase generator, the kva, e.m.f. and power factor being given. J. R. M.

The number of amperes per terminal of a three-phase generator can be determined directly from the rated kva and the e.m.f. of the machine. The "equivalent single-phase current" of the machine is found by dividing the rated kva by the e.m.f. In a three-phase machine the actual current per lead wire is equal to the equivalent single-phase current divided by a constant having the value 1.732. The power-factor affects the value of the kilowatt, but the value of the kva is not affected in any respect by the power-factor.

Why is it that the electricity in a 600-volt railway motor will oftentimes flash over a distance of several inches from brush holder to motor shell? Under ordinary conditions 600 volts will not flash over 1/32 in. unless an arc is started. J. L.

Although the distance over which 600 volts under ordinary conditions will cause an arc to be produced is very short, observation shows that this e.m.f. is sufficient to maintain an arc of considerable length after it has once been formed. In an ordinary 600-volt, direct-current railway motor the normal e.m.f. between adjacent segments would obviously be very much less than 600 volts, in fact often less than ten volts. However, there may be produced between adjacent segments an e.m.f. having a value many times as great as normal under conditions which may be considered somewhat unusual. The abnormal e.m.fs. are produced by rapid rate of change of the flux surrounded by the conductors forming the armature coil. If under any condition whatsoever the flux which a coil surrounds is changed rapidly an enormous e.m.f. is produced between the terminals of the coil. Such a rapid rate of change occurs when the circuit is opened quickly by reason of some accident. It is this abnormal e.m.f. which produces the result frequently referred to as a flash-over, which starts as a miniature arc between two adjacent segments, which combines with a similar arc between neighboring segments, and subsequently spreads over the whole commutator, finally reaching the brush holder.

A 2200-volt, three-phase line feeds a bank of three single-phase transformers, and it is desired to deliver 220-volt, three-phase current to a motor circuit and 110 volts, single or polyphase, to lamp circuits from the secondaries of these transformers. Is it possible or practicable to delta-connect the primary and secondary circuits, supplying the 220-volt, three-phase current to the motor from this connection and also supplying 220-110 volts to the lamp circuits with the wire that corresponds to the neutral of a three-wire, direct-current grounded system? Y. H. C.

It is not possible to ground a three-phase system, such as you describe, at more than one point without causing destructive currents between the phases. However, it is entirely unnecessary to ground the system at more than one point. If your three-phase system is grounded by earthing the neutral point of one of your three-wire systems, then the two outer wires of these three-phase systems will be at a potential of 110 volts above ground and the two neutral points of the other two three-wire systems will be at the same potential above ground. The only wire of the whole system that will be at a higher potential will be the outer three-phase main lead, which will be at a potential of 190 volts above ground.

I have a 20-hp, 500-volt, direct-current, four-pole, four-brush motor which was recently changed to work on a 250-volt circuit, by paralleling the field coils and the armature coils. The armature has 97 bars and the connections were from 1 to 49. On changing the winding the armature leads next each other were looped so that instead of two circuits going through the armature there were four. The brushes were increased in size from 3/8 in. thick to 5/8 in. thick, the width and height remaining the same. The connections at the commutator melt, however, after the machine has been in operation about 10 or 12 hours, although the motor is not located in a warm place and receives good attention. The load on the machine is about 55 amp. at most; the brushes show no sign of pitting and cover about 2½ commutator bars. Any information on the cause of the trouble will be appreciated. C. F. K.

From the data given we are led to believe that your 20-hp, 500-volt motor which has 97 bars on the commuator has 49 slots on the armature. Motors of this type are ordinarily provided with armature windings having two coils per slot, and when used at 250 volts the coils in each individual slot are connected in parallel, thereby making a 49-coil machine. This machine is provided with a 49-segment commutator, and is connected with a throw of 1 to 25. When this same machine is to be used on 500 volts the commutator is changed to one having 97 bars, and the armature coils are connected in series, one coil in one of the slots being disconnected entirely from the circuits; the leads in this coil are cut off short and thoroughly insulated from contact with any metallic parts. We believe that your machine is of this type, and hence when connected for 250 volts should have a 49-segment commutator instead of a 97-segment commutator; in each case the armature would be connected according to the two-circuit arrangement. You have evidently reconnected the machine to give what may be called a parallel arrangement instead of a series arrangement, and if the connections are properly made and the machine is magnetically in good balance, the only effect to be noticed would be an extra amount of heating at the commutator. However, we should have predicted that by changing the brushes as you have done the heating would not have been excessive and the machine would give satisfactory performance. We suggest that you examine the machine carefully and ascertain whether or not, by accident, you have connected in parallel coils which at any chosen instant are surrounded by different amounts of flux, so that with the rotation of the armature there is generated in a closed circuit a certain alternating e.m.f. which would produce local heating at the point where these coils are joined together, namely at the commutator. It might be well for us to mention that even if the connections are properly made according to the method which you intended to use, the brush short-circuits a considerable number of segments, and by this means produces quite an amount of local heating at the point of connection between the armature leads and the commutator segments.

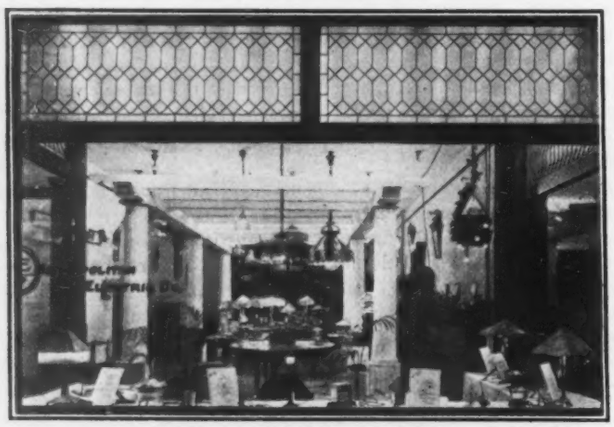
Central Station
Management, Policies and Commercial Methods

LICENSING ELECTRICIANS AT PUEBLO, COL.

The City Council of Pueblo, Col., has enacted an ordinance creating a city electrician and making specific stipulations regarding electric wiring and those engaged in performing wiring work. The city electrician has the usual powers allotted to him and is governed in his rules and decisions by the *National Electrical Code*. All persons, firms or corporations other than public telephone, telegraph and messenger call companies before installing, repairing or operating any wiring or apparatus within the corporate limits, excepting central power stations and substations belonging to electric light and railway companies, must first procure a license. Three grades are provided: Grade A grants the holder the right to install and repair electric wiring or apparatus, and a fee of $50 is charged for the license; grade B entitles the holder to attend to the maintenance and operation of electric wiring and apparatus in any single generating plant under one management, and the fee for the license is $15; grade C grants the owner the right to operate moving-picture machines and theater switchboards and costs $5. In addition bonds of $1,000, $500 and $500 are required of each licensee under the respective grades designated. Iron conduit is specified for all interior wiring within the inner fire district and for all wiring in public mercantile and factory buildings in the outer and urban districts. Except in the case of private residences all main-line switches and cut-outs must be installed on the outside of the building. The feed wires where practicable must enter the rear of the building and one main-line switch and cut-out must control all the wires of the same voltage in any one building for each 25 ft. of frontage. A failure to comply with the ordinance subjects the offender to a fine of not more than $100 or less than $5.

CENTRAL-STATION ADVERTISING.

The Metropolitan Electric Company, of Reading, Pa., believes in the efficacy of advertising, and during the year has brought out a number of cleverly devised advertisements. The



Window and Interior Display of Metropolitan Electric Company.

mediums employed are the backs of monthly bills, mountain railways and folders, in addition to the city directory and *Financial Bulletin*. In its flatiron campaign the poster in the cars leading up the mountain to pleasure resorts bore the catch line "A family is known by the flatiron it keeps." In letters to customers the same catch line was employed with the following addition: "Let us make you a known quantity by selling you an electric flatiron." In its flatiron campaign the Metropolitan Electric Company placed the irons out on a fifteen-day trial with the proviso that those who wished could purchase the iron for $4. A leaflet pointing out the merits of the electric flatiron was illustrated with an engraving showing a Chinese laundryman employing one, underneath which was the caption "Electric flatirons save soles. Note the Celestial smile."

The advertisement in the city directory is devoted to pointing out the merits of electricity in the home and is illustrated with a dining-room cartoon; while the advertisement in the *Financial Bulletin* calls attention to electric signs and is illustrated by an engraving of a national bank sign. A very neat calendar inviting the recipient to live the electric life because it is cheap, clean and convenient is issued by the company. On the back of the company's monthly bills is printed an illustrated story on some convenient electrical household device, such as a luminous radiator, a heating pad, a shaving cup, a cigar lighter, etc.

The company invites its patrons to visit its showroom, where a liberal education in things electrical may be obtained. The showroom is artistically arranged with electrical apparatus and a very attractive effect is given to the display by the white pergola which extends the length of the room. This was made of a wooden frame covered with white cloth and painted. Ferns and other decorations were used to add to the attractiveness of the setting.

INTERVALS FOR TESTING WATT-HOUR METERS.

By John Gilmartin.

When considering methods of maintaining the accuracy of residence meters the selection of the proper test interval is one of the most important problems the meter department has to solve. For the purpose of discussion it may be stated that the problem may be approached from two viewpoints which may be called the ethical and the economic, and reasoning from the same data the desirable interval may vary according to the point of view.

From the ethical viewpoint it would be held that it is the company's duty to know that its customers' meters are accurate within reasonable commercial limits and most especially that they do not run fast. On the other hand is the fact that the average electric meter in service to-day tends gradually to become slow in time, and, therefore, from the economic viewpoint, it is profitable for the company to calibrate its meters periodically. Further consideration shows that in certain respects the ethical and economic viewpoints are identical. For instance, if a company allows its meters to become slow it not only wrongs itself, economically speaking, but it fails in its duty to its consumers because, as has been pointed out elsewhere, if some consumers' meters are correct and others are slow, the consumers with the correct meters are in effect being discriminated against, as they are paying a higher rate per kw-hour than their neighbors who have nominally the same rate but whose meters are slow.

On the other hand, if the meters should be generally fast, the company would not only be failing in its duty, ethically speaking, but in the long run it would suffer financial loss because there would be a bad effect on the business if it became known that the company allowed its meters to become fast, and it might hinder the extension of its business even if not known. If it is granted that the average meter becomes slow as time goes on, from the economic viewpoint, then, the theoretically correct test interval would be that which would result in the lowest annual sum of the two items, value of lost energy and testing expense. That is, it is proper to shorten the test interval up to the point where any further increase in

revenue due to higher meter accuracy will be more than offset by the amount expended in making the tests and adjustments. To determine that point intelligently the meter department must know the following: (1) The cost to test and adjust each type of meter in the various classes of service. (2) How the meter accuracy falls off as time goes on. (3) How to apply the meter accuracy curve to the income from each class of consumers and estimate the amount of revenue lost.

Cost to Test.—This item may be definitely ascertained and is usually known offhand. For residence service 45 cents per test is here assumed as being a fair value. It covers labor and a few minor items of expense. The largest item for material is probably jewels, but it is not believed the omission of material from the calculations would have any effect worth noting on the comparisons. Induction meters can undoubtedly be tested and adjusted somewhat more cheaply than can the commutator type, but the difference is not great and for the present purpose the two are assumed equal. Tests are assumed to be made on the consumer's premises.

Meter Accuracy.—The rate at which the accuracy of a given type of meter falls off can only be known from results secured in actual service. In general the accuracy secured varies between different types, the induction type being superior to the commutator; sometimes results vary between different styles of the same type, or with local conditions, or with the type of bearing and several other items that are quite well known. It is therefore desirable, in giving results secured, to state the meter type, etc. The curves in Fig. 1 show average results of a large number of tests made in actual service. They apply to commutator meters of about the average type now in service, not the very old types nor the very latest, and are for meters having sapphire jewel bearings. The results in Fig. 2 for induction meters were secured similarly to the above and are for a good type of meter. They may be taken as representative of the better types of induction meters now in service, the jewels being sapphire and the shaft ends medium sharp.

When a meter is found to be slow there is a question as to how long it has been in this condition. If a meter is found

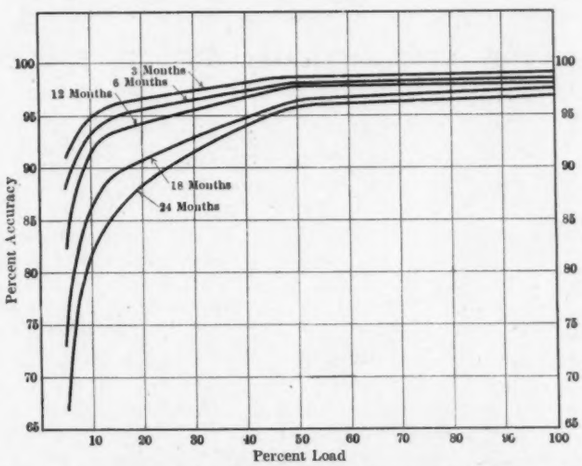


Fig. 1—Curves Showing Increase in Error with Time. Commutator Meters of Medium Old Type. Sapphire Jewels.

10 per cent slow after a year of service it would not be proper to divide the year's kw-hours by 0.90 to find the correct kw-hours because the meter may have gradually become slow. The curves of Figs. 1 and 2 indicate that the average meter slows up at a fairly even rate and in calculating the lost revenue for the various test intervals it is so assumed. For instance, for the twelve-month interval it is assumed that the six-month curve represents the average accuracy for the twelve months.

Lost Revenue.—The amount of revenue lost through slow meters is, as a rule, difficult to determine. In the case of an alternating-current system a meter may sometimes be installed in the primary circuit and its kw-hour reading compared with the sum of the kw-hours of the consumers' meters on that circuit. All of the meters on the circuit can then be tested and adjusted and a new comparison made. If the circuit has not been altered between comparisons the two comparisons should show the approximate loss due to slow meters. This method is complicated by the presence of line and other losses which may exceed and tend to mask the energy loss due to slow meters. As the primary circuits in large systems are frequently interconnected, and direct-current circuits almost invariably so, it is frequently impossible to make the comparisons. Because of the above and other practical difficulties this method is not frequently employed.

The usual method is to test the meters and by applying the necessary correction, as shown by the tests, to the registration of the meter the lost revenue can be calculated. The principal difficulty in using this plan is due to the well-known shape of the meter calibration curve when friction is present in the meter. (See Figs. 1 and 2.) As the meter error varies with

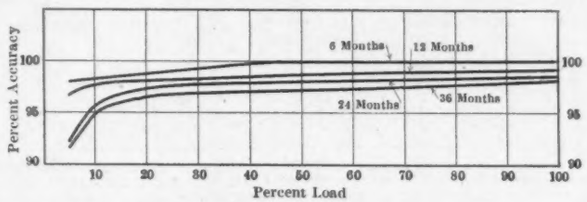


Fig. 2—Curves Showing Increase in Error with Time. Induction Meters of Good Type. Sapphire Jewels.

the load, it is necessary to know at what per cent of full load the meter is working before the percentage error can be stated and the lost revenue due to a slow meter be calculated. Usually the load on a meter varies considerably during each twenty-four hours, and it is therefore necessary to estimate the average error in order to calculate lost revenue. In order to do this it is necessary to know the shape of the consumer's load curve.

Residence Service.—A good approximation for the average accuracy of meters in residence service is the rule of the Public Service Commission of the First District, New York,

TABLE I.—PER CENT OF TOTAL REGISTRATION RECORDED AT VARIOUS PER CENT OF METER RATING.

Per cent meter rating.....	5	10	15	20	25	35	50	60 and above.
Per cent total registration.	9.4	8.5	9.2	10.5	12.2	15.7	14.3	20.2

which assumes that one-fourth of the connected load is the normal load and in calculating the average error the normal load error is multiplied by three and added to the one-tenth and the full-load error and the result divided by five. Table I gives the registration at various per cents of the meter rating as taken from a considerable number of tests on residence

TABLE II.—METHOD OF CALCULATING ERRORS.

Product of Registration and Per Cent. Error	Product
9.4x27.	254
8.5x14	119
9.2x10.5	100
10.5x 9.5	96.5
12.2x 8	97.6
15.7x 6	94
14.3x 3.7	52.8
20.2x 3	60.6
Totals.... 100	874.5

Average error 8.745

service. Table II shows the method of calculating the average accuracy when using the results of Table I and the meter performance curves in Figs. 1 and 2. Table II is based on the three-year interval, using the eighteen-month curve for showing the average percentage error over the total three-year interval.

The values in Table I and the curves of Figs. 1 and 2 are used in making up Table III. For a given per cent slow the lost revenue depends on the annual income from the meter, and therefore in considering residence service it is necessary to know the income from the average consumer.

The average income from residence consumers is usually estimated at between $20 and $30 per year. After examining the accounts of a considerable number of residence consumers it seemed that for the purpose of this article they could be classified into small, medium and large consumers. The average annual income of a number of small consumers was found to be $16.66, and probably a considerable percentage of the residence consumers in every city fall in this class. The medium consumer is another fairly large class and a number of these were found to average $20.50. From $30 and up the number of consumers is smaller than the other two classes, but still quite numerous, and for the present purpose values of $35 and $50 have been assumed. The four values of income here mentioned cover a wide range in residence service and are used in Table III as the basis on which to determine the lost revenue. The form of rate may in some cases have an effect on the loss due to a slow meter. The usual rates for residence service are either a straight energy charge, usually between 8 cents and 12 cents per kw-hour, or some form of the primary and secondary rates, such as 16 cents per kw-hour for a certain number of units and 5 cents for the remainder. A minimum charge is used with each of the rate systems, but the writer believes the minimum is somewhat lower with the primary and secondary system. A form of rate seldom or never used in residence service is a fixed charge per month per kilowatt of demand plus a small energy charge, usually from 1 cent to 2 cents per kw-hour.

Under this form of contract the kw-hour charge is sometimes a small part of the total bill, and the effect of a slow meter extends only to the kw-hour part of the bill, and should not be applied on the whole bill. The minimum charge is another item to be considered, as there are several months in the year when the kw-hours used by the average residence are well below the minimum and the meter error has no effect on the revenue, and therefore the money received for such months should be deducted from the total annual revenue when considering the loss due to slow meters. The accounts showed that 28 per cent of the revenue from the small consumers was from the minimum charge and therefore could not be affected by the meter error, and hence this is deducted from the total revenue as shown in Table III. For the medium customers the value was 15 per cent, while for the $35 and $50 consumers an arbitrary deduction was made as shown in Table III.

TABLE III.—EFFECT OF VARIOUS TEST INTERVALS ON LOST REVENUE. RESIDENCE SERVICE.

COMMUTATOR METERS.

Annual Gross Revenue Received	Annual Revenue Above Min. Charge	Annual Lost Revenue due to Slow Meters for Test Intervals as Below					Annual Lost Revenue due to Slow Meters plus Annual Testing Expense for Test Intervals as Below					Proper Test Interval
		6 Months	9 Months	1 Year	2 Years	3 Years	6 Months	9 Months	1 Year	2 Years	3 Years	
$16.66	$12.00	$0.36	$0.39	$0.44	$0.67	$1.05	$1.26	$0.99	$0.89	$0.90	$1.20	1 Year
20.50	17.50	.53	.57	.64	.98	1.53	1.43	1.17	1.09	1.21	1.68	1 Year
35.00	32.00	.96	1.04	1.16	1.80	2.80	1.86	1.64	1.61	2.02	2.95	9 Months
50.00	45.00	1.35	1.46	1.63	2.52	3.93	2.25	2.06	2.08	2.74	4.08	9 Months
Average % slow		3.02	3.25	3.63	5.62	8.74						

INDUCTION METERS.

		4 Years				4 Years					
16.66	12.00	.36	.09	.23	.30	.47		.54	.46	.45	2 Years
20.50	17.50	.52	.13	.33	.44	.63		.58	.56	.59	2 Years
35.00	32.00	.95	.24	.60	.80	1.06		.69	.83	.95	1 Year
50.00	45.00	1.34	.34	.85	1.12	1.45		.79	1.07	1.27	1 Year
Average % slow		2.98	.75	1.88	2.50						

The average percentage error being taken as one-fifth of the sum of three times the one-fourth load error plus the one-tenth load error plus the full load error, for commutator meters the errors for six-month, nine-month, one-year, two-year and three-year intervals are 3.0, 3.2, 3.42, 5.2 and 8.2 per cent, respectively; for induction meters the errors for one-year, two-year, three-year and four-year intervals are 1.0, 1.92, 2.34 and 2.7 per cent, respectively.

SUMMARY.

Table III gives the desirable test intervals based on the methods and data discussed in this article. It is not pretended that the values given are rigidly applicable to any meter system, because local conditions may alter the conclusions. For instance, the latest and best types of meters will give better results than those shown in Figs. 1 and 2, or the use of diamond jewels would improve the results shown in Fig. 1, etc. It is believed, however, that, under the limitations given in connection with the data and figures, they will be found very closely correct.

The ratio of meter rating to connected load is assumed at from 0.9 to 1.0 and where this ratio is greater the results here given would be affected. There is not much choice between several desirable test-intervals in some of the cases in Table II, but other conditions being equal the shorter test-interval is the better. It must be borne in mind that the curves in Figs. 1 and 2 are averages of all meters, fast and slow, and therefore some meters are considerably faster and some considerably slower than the average shown by the curves.

The more frequent test-interval would lessen the variation from the average, and therefore, other things being at all equal, it is the most desirable from the ethical viewpoint. Considering inspection and energy theft the more frequent test-interval is also found to be the better.

MOTOR LOAD OF MASSACHUSETTS CENTRAL STATIONS.

By Walter Stuart Kelley.

The object of the statistics employed in this article is to discover tendencies from which laws of development may be deduced. The results in individual cases are interesting, but not conclusive, and only by massing data are the results of general value. Too much dependence should not be placed on individual results obtained by a process of averaging. Here, again, tendencies will be shown; the results will be correct relatively, but may not be exact for any individual case. For instance, the ihp values given in Tables III and IV are derived from the brake hp cost at the motor pulley times the combined efficiencies of the various processes from motor pulley to engine cylinders. The efficiencies taken are intended to average the conditions met with as to motor losses, transmission losses, generator and switchboard losses and engine losses. These may not be exactly reproduced in any individual case, yet applied to a large number of cases the tendency with respect to other factors involved will be accurately shown. They will vary somewhat for each individual motor drive, but a person in position to know the local values in any particular instance may arrive at accurate results, if such local values are utilized by the method outlined.

In what is shown here management is perhaps the chief factor. The endeavor has been to differentiate results so as to show what other factors have influence and to indicate the relative value of such influence. The results should afford a corrective in many cases, but here, as elsewhere, a little knowledge is a dangerous thing. The best experience and judgment along the line of power-service development should

be used. Central-station managers should not hesitate to go outside their own ranks to secure it temporarily if they wish to make the most of the situation.

Massachusetts central stations have not been taken because they are in any way different from others, but because they are representative. As a rule, they carry considerable motor load, and the data required are available. The presentation is mainly tabulated data under different groupings. It will be observed that most of the data used are not to be found directly in published reports of central stations. The data used are mostly derived from those published from several different sources.

TABLE I.—MOTOR DATA ON MASSACHUSETTS STATIONS.

Cities	Motors		Kw-Hours Sold	Receipts
	H.P.	No.		
Newburyport	376½	58	427,500	$11,628.12
Marlboro	1028¾	170	516,667	14,259.44
Beverly	296	41	121,241	6,854.40
Northampton	380½	246	134,987	6,330.33
North Adams	1424	201	731,830	21,956.21
Waltham	349 5/10	152	191,617	18,000.00
Pittsfield	1405	195	591,651	22,965.70
Gloucester	677	104	85,296	10,051.56
Quincy	775	42	248,537	19,766.88
Fitchburg	2768½	502	2,316,561	50,152.04
Chelsea	854½	87	335,454	16,507.29
Salem	2231½	310	731,113	24,132.78
Haverhill	2055 5/10	375	1,702,929	44,097.01
Charlestown	743	166	197,450	12,305.21
Newton	483¾	168	198,606	13,102.42
Brockton	2169	309	1,247,979	44,052.97
Lynn	3863	629	2,977,674	70,918.59
New Bedford	728½	194	265,256	15,520.69
Springfield	6428	767	3,912,040	97,778.85
Lawrence	2294 5/10	556	850,000	34,622.09
Cambridge	4336	573	2,514,122	72,573.46
Lowell	5306½	496	4,705,934	124,120.79
Malden	1753	311	881,109	37,723.98
Fall River	958	410	648,234	33,375.15
Worcester	1959	405	916,642	53,915.96
Chicopee (municipal)	96¾	12	No return	2,560.90
Taunton (municipal)	1148	104	476,917	17,991.10
Holyoke (municipal)	3667½	304	3,309,853	60,431.89

Tables I and II give data taken directly from the reports filed with the Massachusetts Gas and Electric Light Commission for the year ending June 30, 1909; the first gives cities, the second towns, and the lower limit of population is about 10,000. Each table lists municipal plants by themselves. So far as possible, desk and ceiling fans of 1/10 hp and less have been excluded, although in some cases it has not been possible to learn whether such motors were included in the report or not. The reason for excluding them is that they belong to lighting service and very rarely is any income from this source included in receipts from motor service; hence, as the kw-hours and the income are not included in such reports, it would not be just to include the number and horse-power of the fans. It is positively known that such motors are excluded from 18 of the 44 reports used.

TABLE II.—MOTOR DATA ON MASSACHUSETTS STATIONS.

Towns	Motors		Kw-Hours Sold	Receipts
	HP.	No.		
Greenfield	1350	253	671,679	$18,047.83
Uxbridge	92½	18	41,617	1,790.07
Weymouth	252	26	23,395	6,888.56
Ware	5½	6	619	81.06
Gardner	483	54	233,827	7,050.99
Adams	123	24	24,534	1,214.65
Abington and Rockland	478	78	417,043	15,802.85
Attleboro	1636½	348	1,170,568	33,452.54
Plymouth	563	47	295,158	13,143.01
Milford	55½	23	27,359	2,545.78
Hyde Park	58½	9	25,379	2,565.78
Clinton	78	10	50,508	2,210.06
Leominster	577½	74	471,602	20,052.57
Revere	650½	74	55,800	5,150.61
Webster	206	31	141,764	2,694.41
Danvers (municipal)	237.5	28	173,296	6,931.85
Peabody (municipal)	51½	32	19,227	2,164.71
Westfield (municipal)	363¾	75	247,700	6,102.55

Aside from errors of bookkeeping to which the data in all four columns in Tables I and II are equally liable, the column headed "Kw-Hours Sold" is most liable to misrepresent the actual condition, as a few stations still sell energy for motors partly by contract, and while the income is correctly reported the kw-hours for such contract energy may not appear in that column. Where stations have a combined rate for lamp and motor circuits or take special contracts for lamps and motors at a single meter rate the latter element, unless estimated, is not likely to appear in either of the last two columns. While the presence of these sources of error is annoying to the investigator, the errors will be in some measure eliminated in the analysis that follows, and in any event, though having some influence on individual results, they will not seriously affect general conclusions.

The Edison Electric Illuminating Company of Boston is not included in the list of companies because it is impossible to distinguish between Boston and the twenty-five or more towns and villages covered by its lines, and combined contracts prevail to such an extent as to make the reported data valueless for the purpose in view.

Tables III and IV give, in addition to population, many other data derived in part from Tables I and II, and the order of presentation is based on population. The population given is not always that of the city itself. Central stations in some cities cover a considerable suburban population. To put all cities as nearly as possible on the same basis one-half of suburban population served has been added to the city population.

Column 4 gives the ratio of energy sold for motors to the combined energy sold for lamps and motors. For the purpose of this consideration all energy sold to other central stations and to street railways has been eliminated; this applies to all the data considered.

Column 5 gives the ratio of income from energy sold for motors to the total income from energy sold, and affords with column 4 a good basis for judging relatively the extent and profitableness of the motor load.

At this point it is desirable to determine approximately the relative cost of furnishing service. For this purpose the inventory values and operating costs of six representative central stations have been studied, the cities served having an aggregate population of about 205,000. The items of operating expense are as follows: Station, all items of outgo for operation and maintenance except labor; distribution, all items of outgo for operation and maintenance outside of office and station, except labor; fuel, all the stations included in this list used coal; labor, all except office; management, salaries, office expense, taxes and miscellaneous expense connected with these; depreciation, which represents 5 per cent on station and equipment and 10 per cent on lines, transformers, meters and arc lamps. The six stations average out as follows:

The first section of the table represents the average of the six stations under each item for combined service. The values in the last two columns are the estimated proportionate values on the same output for each of the two kinds of service. It will be noted that the ratio of one to the other is 1.94; therefore on this basis a kw-hour of energy for lamps delivered at meter is worth (costs) nearly double a kw-hour of energy used for motors. This value may be safely taken as, under ordinary conditions, between 1.8 and 2.

Referring again to Table IV, the items in column 5 should be approximately one-half the value of the items in column 4 if the two services are equally profitable. If the ratio is much less than 2, the power is charged relatively more than the lighting; if the ratio is more than 2, either the energy rate for motors is too low or the energy rate for lamps is too high. Exceptional local conditions will, of course, modify this relation of the two kinds of service.

Column 6 gives the total energy returned divided by the working hours for a year. This will in any given case be cut down by the amount of energy delivered outside of the hours

of the regular working day; 2800 hours have been taken as a fair average for the year. The great bulk of the energy is used within this period, which represents actually 9.12 hours per day for 307 days.

Column 7 gives the aggregate brake hp of motors corresponding to the continuous watts used as per column 6. The brake hp is found by taking a fair average working value for the efficienty of the average-size motor given in column 3. It should be borne in mind that these efficiencies are for the average motor load, not for full load of the size motor given. If anything, these efficiencies are high.

Column 8 gives the ratio of continuous horse-power to the total horse-power in motors connected. It is hardly necessary to add that it is desirable to have this value as high as possible, and that high rates mean a low load factor. It will be noted that all stations having a load factor of 30 and over realize less than 3 cents per kw-hour. With a load factor of 30 the fluctuations in load will be very much less than where the load factor is only 12.

Column 9 gives the price per kw-hour, and is derived from the energy income from motors and the kw-hours sold for the year. If all energy for motors sold is included in the kw-hour return the figures in this column will be correct barring, of course, errors of bookkeeping. The majority are undoubtedly substantially correct. Naturally, one expects to find the average price as shown in this column within the maximum and minimum rates. The rate, however, does not always govern the results, for where most customers use a single motor on an intermittent load the minimum charge may become the determining factor and cause the average rate to be high. This column will, of course, show a high value wherever all energy sold as covered by income is not included in the kw-hour return.

Again, where the station management has been induced to make a specially low rate to take on some large customer, the average price will be less than warranted by the regular price scale.

With competent engineering services furnished to all customers to assure the most advantageous use of energy and a proper price scale, every contract will produce its share of profit.

Column 10 gives the average cost per hp-year at motor pulley. These values are obtained from the motor energy income and the continuous motor load. If they favor either side the values are more likely to be a trifle high than low.

Column 11 gives the average price realized per engine ihp,

TABLE III.—DATA OF MASSACHUSETTS STATIONS, CITIES.

Cities	Population		HP. per Motor	Per Cent Power Ratios		Continuous Load		Motor Load Factor	Cents per Kw-Hour	HP Costs		Transmission Efficiency
	1909 (est.)	per HP.		Kw-Hour	Income	Watts	HP.			Motor Pulley	I.H.P.	
Newburyport	14,675	39	6.49	55.37	26.01	129,418	133.3	35.4	3.20	$87.23	$51.03	58.50
Marlboro	16,450	16	6.05	49.68	21.05	184,524	189.0	18.4	2.75	75.44	43.90	58.20
Beverly	17,309	58.5	7.22	11.52	7.95	43,300	44.9	15.2	5.65	152.66	90.01	58.96
Northampton	20,705	54.6	1.54	15.04	8.34	48,195	45.9	12.0	4.68	137.91	74.58	54.08
North Adams	24,018	16.9	7.08	56.24	20.94	261,368	270.8	19.0	3.00	81.06	47.74	58.88
Waltham	27,600	78.9	2.30	24.14	21.35	68,434	66.2	19	9.39	271.90	149.33	54.92
Pittsfield	27,762	19.8	7.20	24.47	18.19	211,304	219.2	15.6	3.88	104.77	61.77	58.96
Gloucester	30,458	45	6.52	11.53	11.45	30,463	31.4	4.5	11.78	320.11	187.26	58.50
Quincy	30,500	39.3	18.45	26.36	18.66	88,763	98.1	12.7	7.95	201.43	126.90	63.00
Fitchburg	34,670	12.5	5.51	61.18	37.07	827,343	841.6	30.4	2.16	59.59	34.45	57.82
Chelsea	37,289	43.6	9.82	36.68	22.76	119,805	127.2	14.9	4.92	129.77	78.32	60.33
Salem	38,380	17.2	7.19	32.52	14.22	261,112	270.9	12.1	3.30	89.08	52.52	58.96
Haverhill	38,400	18.7	5.48	59.38	29.05	608,189	618.7	30	2.58	71.27	41.22	57.82
Charlestown	40,452	54.4	4.48	38.49	16.63	70,500	70.7	9.5	6.23	174.05	99.17	56.98
Newton	51,400	106.2	2.88	12.00	9.15	70,894	69.3	14.1	6.59	189.07	105.04	55.53
Brockton	56,323	26	7.02	35.73	19.26	445,707	461.4	21.2	3.52	95.48	56.16	58.81
Lynn	82,034	21.2	6.14	45.69	20.34	1,063,455	1090.7	28.3	2.38	65.02	37.89	58.27
New Bedford	82,464	113.2	3.75	14.96	9.84	94,147	94.0	12.9	5.85	165.11	93.07	56.37
Springfield	84,348	13.1	8.38	32.28	19.69	1,397,157	1467.6	22.9	2.49	66.26	39.51	59.65
Lawrence	87,995	38.3	4.13	25.63	15.31	303,566	303.6	13.2	4.07	114.04	70.39	56.75
Cambridge	101,330	23.4	7.56	45.83	23.39	897,901	934.3	21.5	2.88	77.68	45.93	59.11
Lowell	106,248	20	10.69	60.70	35.63	1,680,691	1795.6	33.8	2.63	69.12	41.97	60.71
Malden	109,200	62.3	5.63	24.82	13.88	314,682	320.8	12.6	4.28	117.62	68.10	57.89
Fall River	109,463	114.3	2.33	20.29	14.56	231,513	223.9	23.4	5.14	149.06	81.55	54.93
Worcester	137,632	70.2	4.84	18.78	15.41	327,158	329.8	16.8	5.88	163.48	93.68	57.28
Chicopee (municipal plant)	21,600	223.2	8.06	.....	10.9	.....	.....	.....	.....	.....	.....	.....
Taunton (municipal plant)	32,600	27.5	11.04	24.82	32.64	170,328	182.4	15.9	3.772	98.63	60.03	60.86
Holyoke (municipal plant)	53,930	14.7	12.06	54.01	36.50	1,182,090	1274.0	34.7	1.826	47.43	29.02	61.24

TABLE IV.—DATA OF MASSACHUSETTS STATIONS, TOWNS.

Towns	Population		HP. per Motor	Per Cent Power Ratios		Continuous Load		Motor Load Factor	Cents per Kw-Hour	HP Costs		Transmission Efficiency
	1909 (est.)	per HP.		Kw-Hour	Income	Watts	HP.			Motor Pulley	I.H.P.	
Greenfield	9,609	7.12	5.33	57.51	28.26	329,885	243.5	18.0	2.68	$74.12	$42.72	57.66
Uxbridge	11,810	128.00	5.13	17.45	6.49	11,292	11.4	12.3	4.30	157.00	90.29	57.51
Gardner	13,093	27.1	8.94	45.52	18.90	83,509	88.0	18.2	3.01	80.12	47.97	59.87
Adams	13,610	110.6	5.12	12.78	4.95	8,764	8.8	7.2	4.95	138.02	79.38	57.51
Attleboro	13,970	8.5	4.70	66.48	39.11	418,053	421.0	25.7	2.85	79.46	45.46	57.21
Abington and Rockland	14,018	29.3	6.13	59.86	25.93	148,944	152.8	31.9	3.79	103.42	60.27	58.27
Plymouth	14,790	26.3	11.98	45.39	28.53	105,414	113.6	20.2	4.45	115.70	70.81	61.24
Milford	14,810	26.7	2.41	11.78	9.95	9,771	9.4	17	9.30	270.83	149.16	55.07
Hyde Park	15,526	265.4	6.50	7.30	6.57	9,135	9.4	16.1	10.10	272.96	159.69	58.50
Clinton	16,107	206.5	7.80	13.76	6.38	18,053	18.6	22.6	4.37	118.82	70.42	59.26
Leominster	16,372	28.3	7.80	54.15	33.14	168,429	175.6	30.4	4.25	114.19	67.67	59.26
Revere	18,497	28.4	8.79	2.36	3.37	19,929	21.0	3.2	9.23	245.27	146.67	59.80
Webster	30,031	145.8	6.64	19.73	5.28	50,630	52.2	25.3	1.90	97.70	57.23	58.58
Danvers (municipal plant)	9,516	40.1	8.48	36.04	27.29	61,891	65.0	27.3	4.00	106.64	63.61	59.65
Peabody (municipal plant)	14,015	73.1	4.46	3.89	8.84	6,867	6.9	3.6	11.25	303.73	172.92	57.06
Westfield	14,699	40.5	4.84	32.26	25.10	88,464	89.2	24.5	2.46	68.41	39.19	57.28

corresponding to the value per brake hp at motor pulley given in column 10. This includes all costs incident to furnishing electric energy at meter plus whatever profit is realized.

The values given run from $29.02 to $187.26, and it is significant that the lowest value is found in a municipal plant.

TABLE V.—COST OF SERVICE.

Items	Combined Service		Proportion of All	
	Costs	Per Cent	Motors Per Cent	Lamps Per Cent
Station	$10,049	10	7	13
Distribution	12,126	12	8	22
Fuel	16,180	16	11	20
Labor	13,500	14	9	18
Management	19,654	20	14	24
Depreciation	28,491	28	19	35
Totals	$100,000	100	68	132

One is to be censured as much on the score of policy as is the other from the standpoint of profit.

In tables that follow returns that seem in any way abnormal, or give indications of error, have been omitted; likewise all that do not show a continuous motor load of 40 hp. Tables

TABLE VI.—CLASSIFICATION BY INDUSTRIES.

Place	Industry, Per Cent	Population per HP	HP. per Motor	Power Ratio Kw-H	Continuous Motor HP	Motor Load Factor	Cents per Kw-H	Price Realized per IHP
TEXTILES								
New Bedford	82	113.2	3.75	14.96	94.0	12.9	5.85	$93.07
Plymouth	.....	26.3	11.98	45.39	113.6	20.2	4.45	70.81
Taunton	39	27.5	11.04	24.82	182.4	15.9	3.77	60.03
Fall River	79	114.3	2.33	20.29	223.9	23.4	5.14	81.55
North Adams	70	16.9	7.08	56.24	270.8	19.0	3.00	47.74
Lawrence	81	38.3	4.13	25.63	303.6	13.2	4.07	70.39
Holyoke	37	14.7	12.06	54.01	1274.0	34.7	1.82	29.02
Lowell	53	20	10.69	60.70	1795.6	33.8	2.63	41.97
Average	.....	46.4	7.88	37.75	.....	21.6	3.84	.....
BOOTS, SHOES AND LEATHER								
Beverly	44	58.5	7.22	11.52	44.9	15.2	5.65	$90.01
Danvers	.....	40.1	8.48	36.04	65.0	27.3	4.00	63.61
Abington	.....	29.3	6.13	59.86	152.8	31.9	3.79	60.27
Marlboro	95	16	6.05	49.68	189.0	18.4	2.75	43.90
Salem	70	17.2	7.19	32.52	270.9	12.1	3.30	52.52
Brockton	92	26	7.02	35.72	461.4	21.2	3.52	56.16
Haverill	83	18.7	5.48	59.38	618.7	30	2.58	41.22
Lynn	79	21.2	6.14	45.69	1090.7	28.3	2.38	37.89
Average	.....	28.4	6.71	41.30	.....	23	3.50	.....
DIVERSIFIED INDUSTRIES								
Northampton	54.6	1.54	15.04	49.5	12	4.68	$74.78	
Newton & Watertown	106.2	2.88	12.00	69.3	14.1	6.59	105.04	
Charlestown	54.4	4.48	38.49	70.7	9.5	6.23	99.17	
Chelsea	43.6	9.70	36.68	127.2	14.9	4.92	78.32	
Pittsfield	19.8	7.20	24.47	219.2	15.6	3.88	61.77	
Malden	62.3	5.63	24.82	320.8	12.6	4.28	68.10	
Worcester	70.2	4.84	18.78	329.8	16.8	5.88	93.68	
Fitchburg	12.5	5.51	61.18	841.6	30.4	2.16	34.45	
Cambridge	23.4	7.56	45.83	934.3	21.5	2.88	45.93	
Springfield	13.1	8.38	32.28	1467.6	22.9	2.49	39.50	
Average	46	5.8	30.96	.....	17	4.40	.....	

VI and VII, grouping the different stations according to the prominent industry, will be found of interest. The proportion of the different industries given is that found in Statistics of Manufactures (1908), and where the proportion is not given it was not obtainable.

Among those grouped under "Diversified Industries" none, so far as can be found, has any one industry that turns out 33 1/3 per cent in value of the total manufactured product. The other data in Tables VI and VII are from previous tables, the novelty being in the grouping.

The showing in Table VIII is worth careful study and may not accord with preconceived ideas. The group with diversified industries makes the poorest showing of all; this is doubtless due not to the fact of diversified industries, but to the high price of energy that prevailed, for the three last stations in the "diversified" list, with an average price of 2.5 cents per kw-hour, rank high—among the best as to motor service.

It may be remarked that with one insignificant exception all the factors considered in this table follow in order the range of average price per kw-hour.

Tables IX and X, grouping the straight electric and the gas-electric stations separately, present some interesting compari-

TABLE VII.—CLASSIFICATION BY SPECIALTIES.

Place	Specialty		Population per HP of Motors	H.P. per Motor	Power Ratio Kw-H	Continuous Motor HP	Mot'r Load Factor	Cents per Kw-H	Price Realized per IHP
	Manufacture	Per Cent							
Gardner	Furniture	83	27.1	8.94	45.52	88	18.2	3.01	$47.97
Westfield	Whips	37	40.5	4.84	32.26	89.2	24.5	2.46	39.19
Leominster	Combs, hairpins, etc	37	28.3	7.80	54.15	175.6	30.4	4.25	67.67
Greenfield	Tools and machinery	....	7.1	5.33	28.26	243.5	18	2.68	42.72
Attleboro	Jewelry	60	8.5	4.70	66.48	421.0	25.7	2.85	45.46
Average	.....	.....	22.3	6.32	45.33	.....	23.3	3.05	.....

sons. The usual opinion that the gas-electric station is not so keen after electric business as the straight electric is disproved in instances, but as a whole there seems to be ground for the opinion. As business getters the gas-electric stations

TABLE VIII.—GROUPED INDUSTRIES.

Manufacture	Population per H.P.	Motor Load Ratio, Kw-Hour	Motor Load Factor	Cents per Kw-Hour
Specialties	22.3	45.33	23.3	3.0
Boots, shoes and leather	28.4	41.30	23	3.5
Textiles	46.4	37.75	21.6	3.8
Diversified	46.0	30.96	17	4.4

lag 45.2 per cent behind the straight electric on the population basis. The latter have 1 hp in motors connected to 32.5 people, the former 1 hp to 47.2 people, although the group (gas-electric) includes the three stations having the lowest rates. The group runs to extremes, for besides having the three

TABLE IX.—STRAIGHT ELECTRIC STATIONS.

Place	Population per HP	HP per Motor	Power Ratio Kw-H	Continuous Motor HP	Motor Load Factor	Cents per Kw-H
Fall River	114.3	2.33	15.04	223.9	23.4	5.14
Worcester	70.2	4.84	18.78	329.8	16.8	5.88
Malden	62.3	5.63	24.82	320.8	12.6	4.28
Northampton	54.6	1.54	15.04	45.9	12.0	4.68
Danvers	40.1	8.48	36.04	65.0	27.3	4.00
Abington & Rock'd	29.3	6.13	59.86	152.8	31.9	3.79
Leominster	28.3	7.80	54.15	175.6	30.4	4.25
Taunton	27.5	11.04	24.82	182.4	15.9	3.77
Gardner	27.1	8.94	45.52	88.0	18.2	3.05
Plymouth	26.3	11.98	45.39	113.6	20.2	4.45
Brockton	26	7.02	35.73	461.4	21.2	3.52
Cambridge	23.4	7.56	45.83	934.3	21.5	2.86
Lowell	20	10.69	60.70	1795.6	33.8	2.63
Pittsfield	19.8	7.20	24.47	219.2	15.6	3.88
Haverhill	18.7	5.48	59.38	618.7	30.0	2.58
Salem	17.2	7.19	32.52	270.9	12.1	3.30
Marlboro	16	6.05	49.68	189.0	18.4	2.75
Springfield	13.1	8.38	32.28	1467.6	22.9	2.49
Attleboro	8.5	4.70	66.48	421.0	25.7	2.85
Greenfield	7.1	5.33	57.51	243.5	18.0	2.68
Average	32.5	6.92	40.20	.....	21.4	3.47

stations with the lowest rates, it includes the three having the highest rates. This can hardly be considered complimentary as compared with the straight electric group. The ratio of energy used for motors to that for lamps is 13.7 per cent better for the straight electric stations. These two items afford the essential basis for comparison.

Table XI groups all stations in the order of the average size of motor. In none of the other columns is there a marked

tendency to follow this order, although, as a rule, the low motor load-factors are found with the small sizes, together with a poor population ratio. With the exception of one station there is a consistent grouping of favorable characteristics from 5.33 hp to 7.20 hp, inclusive. This includes all of 5 hp and all of 6 hp. There are here 11 sizes, four in the 5-hp range, three in the 6-hp range and four in the 7-hp range. This seems to be a point worthy some consideration by the management of central stations.

TABLE X.—GAS AND ELECTRIC STATIONS.

Place	Population per HP	HP per Motor	Power Ratio Kw-H	Continuous Motor HP	Motor Load Factor	Cents per Kw-H
New Bedford	113.2	3.75	14.96	94.0	12.9	5.85
Newton & Watert'n	106.0	2.88	12.00	69.3	14.1	6.59
Beverly	58.5	7.22	11.52	44.9	15.2	5.65
Charlestown	54.4	4.48	38.49	70.7	9.5	6.23
Chelsea	43.6	9.70	36.68	127.2	14.9	4.92
Westfield	40.5	4.84	32.26	89.2	24.5	2.46
Lawrence	38.3	4.13	25.63	303.6	13.2	4.07
Lynn	21.2	6.14	45.69	1090.7	28.3	2.38
North Adams	16.9	7.08	56.24	270.8	19	3.00
Holyoke	14.7	12.06	54.01	1274.0	34.7	1.82
Fitchburg	12.5	5.51	61.18	841.6	30.4	2.16
Average	47.2	6.16	35.33	.....	19.7	4.10

It is very significant that while those stations that have the poorest motor load have the highest rates, those that have the lowest rates do not have the best motor load, either on the basis of population or power ratio.

In Table XII stations are grouped according to (a), the three stations with the poorest business based on population; (b), the three with the best business on the same basis, and (c), the three selling energy for motors at the lowest price.

Schedule (a) simply emphasizes what is apparent from an inspection of the full list in Table XI, that high price is an invariable concomitant of a poor motor business relative to population, and with one exception the power ratio is found to be low with high prices. Contrariwise it is seen from schedule (c) that the best business does not necessarily accompany the lowest prices. Schedule (b), with an average rate 20 per cent higher, shows a better motor load, both with respect to population and proportion to lighting.

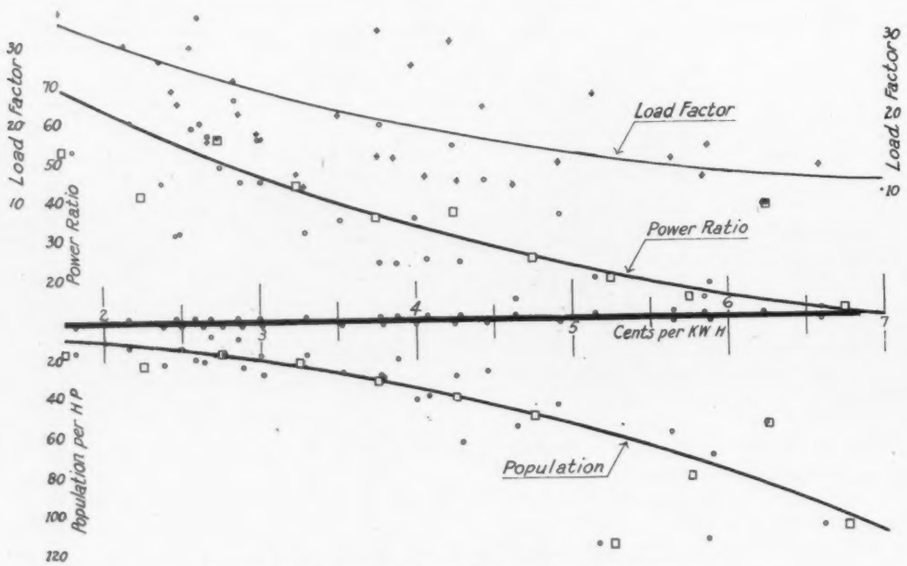
Schedule (b) is representative as to industries. Lowell is mainly textile; Fitchburg textile, paper and machinery; Attleboro, jewelry. Based on this showing, it might be said that a good motor load is one where the population does not exceed 20 to the horse-power, where the ratio of motor kw-hours to combined kw-hours exceeds 60 per cent and where the price realized is not less than 2.5 cents per kw-hour.

A motor load that meets these conditions is good both as regards amount of business and as regards the income derived. Incidentally it may be remarked that a miscellaneous central-station motor load that does not afford an average return of 2.5 cents per kw-hour is not showing the return it should. This price need not be reduced to secure a very much larger load than 1 hp to twenty people, as the schedule in Table XIII shows.

TABLE XI.—STATIONS ARRANGED ACCORDING TO HORSE-POWER OF MOTORS.

Place	Population per HP	HP per Motor	Power Ratios Per Cent		Continuous Motor HP	Motor Load Factor	Cents per Kw-H	Price Realized per IHP
			Kw-H	Inc'me				
Northampton	54.6	1.54	15.04	8.34	45.9	12	4.68	$74.78
Fall River	114.3	2.33	20.29	14.56	223.9	23.4	5.14	81.55
Newton & Wat'n.	106.2	2.88	12.00	9.15	69.3	14.1	6.59	105.04
New Bedford	113.2	3.75	14.96	9.84	94.0	12.9	5.85	93.07
Lawrence	38.3	4.13	25.63	15.31	303.6	13.2	4.07	70.39
Charlestown	54.4	4.48	38.49	16.63	70.7	9.5	6.23	99.17
Attleboro	8.5	4.70	66.48	39.11	421.0	25.7	2.85	45.46
Westfield	40.5	4.84	32.26	25.10	89.2	24.5	2.46	39.19
Worcester	70.2	4.84	18.78	15.41	329.8	16.8	5.88	93.68
Greenfield	7.1	5.33	57.51	28.26	243.5	18.0	2.68	42.72
Haverhill	18.7	5.48	59.38	29.05	618.7	30.0	2.58	41.22
Fitchburg	12.5	5.51	61.18	37.07	841.6	30.4	2.16	34.45
Malden	62.3	5.63	24.82	13.88	320.8	12.6	4.28	68.10
Marlboro	16	6.05	49.68	21.05	189.0	18.4	2.75	43.90
Abington & Roc'd	29.3	6.13	59.86	25.93	152.8	31.9	3.79	60.27
Lynn	21.2	6.14	45.69	20.34	1090.7	28.3	2.38	37.89
Brockton	26	7.02	35.73	19.26	461.4	21.2	3.52	56.16
North Adams	16.9	7.08	56.24	20.94	270.8	19	3.00	47.74
Salem	17.2	7.19	32.52	14.22	270.9	12.1	3.30	52.52
Pittsfield	19.8	7.20	24.47	18.19	219.2	15.6	3.88	61.77
Beverly	58.5	7.22	11.52	7.95	44.9	15.2	5.65	90.01
Cambridge	23.4	7.56	45.83	23.39	934.3	21.5	2.88	45.93
Leominster	28.3	7.80	54.15	33.14	175.6	30.4	4.25	67.67
Springfield	13.1	8.38	32.28	19.69	1467.6	22.9	2.49	39.50
Danvers	40.1	8.48	36.04	27.29	65.0	27.3	4.00	63.61
Gardner	27.1	8.94	45.52	18.90	88.0	18.2	3.01	47.97
Chelsea	43.6	9.70	36.68	22.76	127.2	14.9	4.92	78.32
Lowell	20	10.69	60.70	35.63	1795.6	33.8	2.63	41.97
Taunton	27.5	11.04	24.82	32.64	182.4	15.9	3.77	60.03
Plymouth	26.3	11.98	45.39	28.53	113.6	20.2	4.45	70.81
Holyoke	14.7	12.06	54.01	36.50	1274.0	34.7	1.82	29.02

Taking the list shown in Table XI, the four most important factors of the data given, population per horse-power, power ratio, motor-load factor and price per kw-hour, seem to follow approximately the same law of variation. This is brought out graphically in the accompanying curves.



Power Service Data, Massachusetts Central Stations.

The basis of the three curves is the price per kw-hour plotted as abscissas on the center line. This has been made heavy, and succeeding values are plotted on opposite sides to avoid confusion where two values are nearly the same. Dotted diamonds on the upper part locate load-factor values for every price per kw-hour. The curve represents a fair average of these, the extremes being load-factor 33.5 for a rate of 1.75 cents to load-factor 12 for a rate of 7 cents. Small circles partly in the same field locate power ratio values for every price. These have been averaged for each half cent of price, as shown by the large squares, and show a fairly regular trend; the curve touches five of the ten squares, the extremes connected being seventy for a price of 1.75 cents to ten for a price of 7 cents.

Below the axis of abscissas small circles locate population values, the half-cent average being again shown by large squares, except where there is but a single value to the half cent. These squares are close to the line, five again being intercepted by it. While the same curve is used as before it is reversed—that is, the end farthest from the axis of abscissas is the same above and below. The curvature of the line is not quite uniform, but seems to increase slightly as it leaves the axis, indicating a parabolic tendency. Attention should be called to the fact that the most numerous, as well as the most consistent, grouping of values is between 2.5 cents and 3 cents per kw-hour. It should be noted also that both as to power ratio and as to population the best values are within the same range of price.

TABLE XII.—STATIONS GROUPED ACCORDING TO PROFITABLE BUSINESS.

	Place	Population Ratio	Power Ratio	Cents per Kw-Hour
(a)	Fall River	114.3	20.29	5.149
	New Bedford	113.2	14.96	5.851
	Newton and Watertown	106.0	12.00	6.597
	Average	111.1	15.75	5.865
(b)	Lowell	20.0	60.70	2.637
	Fitchburg	12.5	61.18	2.163
	Attleboro	8.5	66.48	2.858
	Average	13.6	62.78	2.553
(c)	Lynn	21.2	45.69	2.382
	Holyoke	14.7	54.01	1.826
	Fitchburg	12.5	61.18	2.163
	Average	16.1	53.62	2.123

These curves are not presented as limiting values for central stations to reach, but as the average values of Massachusetts central stations for one year ending June 30, 1909. Doubtless many of them are doing much better now; some are certainly doing better because they are giving more attention to the matter of engineering for motor customers.

TABLE XIII.—STATIONS HAVING BEST POPULATION RATIO.

Place	Population Ratio	Power Ratio	Cents per Kw-Hour
Fitchburg	12.5	61.18	2.163
Attleboro	8.5	66.48	2.858
Greenfield	7.1	57.51	2.686
Average	9.3	61.72	2.569

A better showing will certainly be made when more central-station managers appreciate the full significance of these facts: *a*, that motor load is quite a different thing from the lighting business; *b*, that it must be prosecuted along different lines to ensure any considerable measure of success; *c*, that the central station must take measures to assure an economical use of energy by motor users, and, *d*, that every new motor customer located makes some addition to the lighting field. Finally, the motor load is worth cultivating in any way; but it will pay better when cultivated right, not only for its own account, but for its influence in increasing the demand for light.

Wiring and Illumination

SPECIAL STREET LIGHTING IN CHICAGO

The number of special street lighting installations in Chicago, designed to increase the attractiveness of particular localities for the purpose of drawing trade, is constantly increasing. The Commonwealth Edison Company furnishes electrical energy for these lighting equipments, and there are now about 1200 or 1300 posts of this description in the city, supporting about 5000 lamps. A standard type of post has been adopted, such as is shown in Fig. 1. As illustrated, the post supports four lamps, but sometimes a fifth lamp is added directly on top of the post. Sixty-watt tungsten lamps are usually employed

A recent addition to the list of neighborhoods having this special street lighting is West Chicago Avenue from Armour Street to the Metropolitan Elevated Railway tracks. The special street lighting extends for a distance of three and a half blocks and the posts are symmetrically arranged so that the appearance of the street at night is especially attractive. This is not universally the case, as it is not always possible to induce all the merchants to join the movement, so that gaps are sometimes left between the posts. One energetic business man on West Chicago Avenue, however, has secured the allegiance of all his friends and neighbors for the distance mentioned. Each merchant or property owner pays for the lights in front of his own premises. There are fifty posts in this installation, each supporting four 60-watt lamps. Fig. 2 is a general night view showing the equipment on West Chicago Avenue.

Fig. 1—Four-Lamp Post.

Fig. 2—Special Lighting on West Chicago Avenue.

Another installation is on East Thirty-first Street from State Street to Cottage Grove Avenue. Here there are over fifty four-lamp posts. The special street lighting on Halsted Street, near West Twelfth Street, is being remodeled. This is one of

the few installations where arc lamps were used originally. These 300-watt direct-current arc lamps are now being superseded by the four-lamp fixtures, such as the ones illustrated.

TUNGSTEN STREET LIGHTING IN BUFFALO.

An initial installation of eighty-five ornamental tungsten posts was put in operation in Buffalo on Sept. 5 at the opening of the Genesee Street Carnival in that city. Early in July the Genesee Street Business Men's Association began making plans for this carnival and raised a subscription of $2,500 for decorative street lighting, which would, of course, be only temporary. When the matter was taken up with the assistant general manager of the Buffalo General Electric Company he suggested that instead of spending this money for temporary lighting decorations the amount should be increased to $4,000 and invested in tungsten posts, which would be distinctively decorative and after the carnival would still remain and continue to attract attention to the street and its merchants. The suggestion was accepted and in the end eighty-five posts were ordered at a cost of $50 per post, the Buffalo General Electric Company agreeing to furnish and install the posts for this price.

Each post holds five 60-watt tungsten lamps, four pendent and one upright. Thirty of these posts are connected to the

Tungsten Lighting in Buffalo.

underground Edison three-wire system, and the rest are temporarily connected to the overhead 60-cycle system, but are arranged for underground connection and will be changed over within the next year, when all wires on this street will be placed underground. The posts rest upon concrete foundations and are located about 120 ft. apart, as far as possible on the lot line and far enough from the curb to be out of the way of wagon hubs. They are made up of a double pressed-steel column with cast-iron top and base. The clusters remain as the permanent lighting for the street, the Buffalo General Electric Company agreeing to furnish energy and maintenance for 4000 hours' burning per annum at a cost of $37.50 per post. This expense will be borne by the city as the new lamps will take the place of the series arc lamps formerly used for street illumination.

ILLUMINATION AS A FACTOR IN MANUFACTURING COSTS.

At the recent meeting of the National Association of Cotton Manufacturers at the Hotel Wentworth, Newcastle, N. H., a paper on "Illumination as a Factor in Manufacturing Costs" was presented by Mr. A. S. Hubbard, of New York. The author pointed out that human skill is in the long run the final test of productive economy, and that ocular perception is the one controlling act upon which the final results of the human mechanism absolutely depend. Illumination is therefore of fundamental importance in relation to intensified production. Compared with the cost of labor and the value of the product turned out the cost of producing artificial light is so insignificant a factor as to make its serious consideration ridiculous. One cent will pay for the illumination produced for ten hours by two 16-cp carbon lamps, one 80-cp tungsten lamp, one-fifth of an arc lamp or one-fourth of a Cooper-Hewitt lamp. At the rate of $2 wages per day, an operative would have to lose only three minutes to represent a money loss equal to the cost of more light than he would need for an entire ten-hour day. If fixed charges are included on the installation, and maintenance added, the figures can be doubled for the cost of light without any effect on the argument. The question whether to use one-half a watt or two watts per square foot of floor area is superficial unless the efficiency of the human machines is considered.

The general conditions of good illumination are proper intensity, absence of glare and steadiness. The eye can see very comfortably, when it does not have to focus accurately, by an illumination of from 0.25 to 0.50 ft.-candle. This intensity should be provided for passageways, storage-rooms and other places where close eye work is not required. For careful vision on light-colored objects, such as reading print on white paper, writing, etc., from 2.0 to 4.0 ft.-candles is satisfactory. For careful vision on dark colors this intensity should at least be doubled, and where unusually careful vision is required several times this intensity is often used. These figures are based on white light. Glare is the most important single item in artificial illumination. Highly polished surfaces of every description should be avoided where constant eye work is to be done. Streaky illumination, with a bare incandescent lamp and a polished reflector, is nearly as undesirable as unsteadiness of lighting.

Ultra-violet rays, by their intense chemical action, have a destructive effect upon certain tissues of the organs of vision, but no commercial light source at present gives as large a proportion of ultra-violet rays as sunlight. Ordinary lead glass, as used in incandescent bulbs, tubes for mercury-vapor lamps, and the better grade of globes, absorbs nearly all the ultra-violet rays. Most of the troubles attributed to ultra-violet rays are in reality due to direct glare. The mercury-vapor lamp differs from all other sources in leaving out the red rays, which are fatiguing and ineffective in producing vision in proportion to the energy that they contain. The prime essential in textile manufacture is distinctness of vision. The raw materials are made up of exceedingly fine fibers, and in almost the entire process of their treatment the eye must be focused carefully upon objects in which fineness of detail is the chief characteristic. The author pointed out the absence of glare in the mercury-vapor lamp, which requires no diffusing globe and presented the following table of total flux and wattage:

	Watts per Spherical Candle
Carbon incandescent	3.6 to 4.1
Gem	3.1 to 3.5
Tantalum	2.49 to 2.71
Tungsten	1.68 to 1.83
Enclosed arc	2.6 to 3.0
Magnetite arc	0.75 to 1.0
Flaming arc	0.28 to 0.5
Mercury-vapor lamp	0.48 to 0.6

The sawtooth roof construction is now generally utilized for weaving-rooms in modern factories for the reason that it gives the best possible distribution of daylight illumination, producing a uniform intensity over the entire space and still giving a directed light, the effect being perceptibly different from that of a flat skylight. The ideal disposition of artificial light sources is to place them in the angles of such a roof so that they will be out of the direct line of vision of the operatives. In a number of installations where mercury-vapor lamps have been used in textile service it has been found that the product during the hours when artificial light is used is fully equal both in quantity and quality to that produced under the best daylight conditions. The author closed with a discussion of the influence of the subconscious will upon the rate of production, pointing out the importance of good illumination in suggesting progressive application of labor.

WIRING EQUIPMENT FOR MOTOR TESTING.

By Harry S. Travis.

It is often desirable to test motors that are already installed in order to ascertain the power required for certain operations or to find whether a larger or smaller one than the one operating will best satisfy the existing conditions. In making such tests usually the most expensive and tedious portion of the work is connecting the measuring instruments into the motor circuit. This is particularly true where the motor is one of large capacity having large conductors. If motors are tested frequently it saves both time and money to arrange portable wiring equipment by means of which testing instruments can be quickly and effectively inserted in the motor circuits.

Fig. 1 shows the application of such a device that has worked out well. With it instruments can be connected into motor circuits without disturbing the permanent wiring. In the engraving a direct-current motor is shown, but the scheme is quite applicable to three-phase motors. Two dummy fuse connectors will be required for three-phase testing, whereas only one is required in direct-current tests. Referring to Fig. 1: Instead of disconnecting one of the leads to the motor in order to cut in the series coils of the wattmeter the connection is arranged at the fusible cut-out. Nearly all motors are protected with a cut-out of this type. One of the fuses is removed from the cut-out and in its stead is inserted a dummy-fuse-connector like that detailed in Fig. 2. The leads to the wattmeter are connected—frequently permanently—to the binding posts of the connector. There is no path directly through the connector because the old fuse, from which it is made, has been taken apart and all portions of the fusible conductor that it contained removed. The circuit to the motor must, therefore, be completed through the wattmeter.

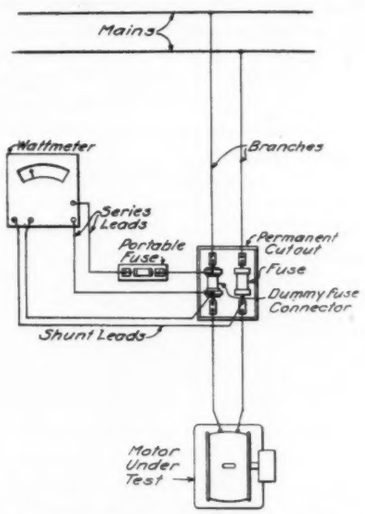


Fig. 1—Connections for Motor Testing.

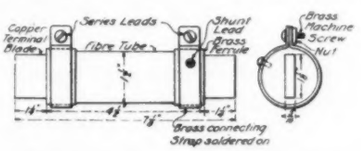


Fig. 2—Connecting Straps on 101-200 Amp. Fuse.

The details of Fig. 2 show how the connector is made. Connecting straps (see Fig. 3) are soldered to the ferrules of what was the fuse. The terminals are arranged by soldering on each connecting strap a nut (see Figs. 2 and 3) into which a brass machine screw turns. Wattmeter leads are either permanently clamped under the heads of the brass machine screws or soldered into lugs of the form shown in Fig. 4. The nut should preferably be of brass, as it can be soldered more easily; but an iron nut will do. In soldering iron the metal must be first filed so that a clean, new surface will be presented and then tinned, using ammonium chloride (sal ammoniac)—in crystalline or powdered form—as a flux, before an attempt is made to solder it to another metal. After the straps are affixed to the ferrules of the old fuse a hole for a small machine screw is drilled and tapped in one of them, as indicated in Fig. 2. This provides means for connecting one of the voltage leads to the wattmeter. Although Fig. 2 only shows a connector for 101-200-amp. National Electrical Code fuse

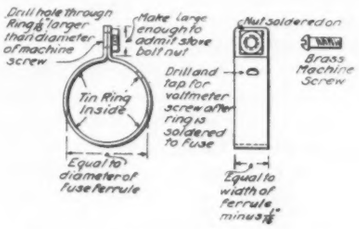

Drill hole through Ring ⅛" larger than diameter of machine screw
Make large enough to admit stove bolt nut
Nut soldered on
Brass Machine Screw
Drill and tap for voltmeter screw after ring is soldered to fuse
Tin Ring Inside
Equal to diameter of fuse ferrule
Equal to width of ferrule minus ⅛"

Fig. 3—Details of Connecting Strap.

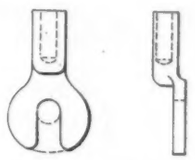


Fig. 4—Lugs for Current Leads.

holders, connectors for the other size code holders can be arranged in essentially the same way. All of the directions given on Fig. 3 are general and apply to all sizes of knife-blade contact fuses.

Where connectors are to be made from ferrule contact fuses—those of capacities under 61 amp—it is best to solder the wattmeter leads directly to the ferrules. Conductors necessary for the relatively small currents involved will be so small that they will not be difficult to handle and there would be no advantage in being able to disconnect them at the ferrules.

The lug shown in Fig. 4, which may be used on the dummy-fuse-connector ends of the wattmeter leads, is made from an ordinary lug by filing out the portion enclosed within the dotted lines in the figure. The advantage of this type of "forked" lug is that it may be inserted under a machine screw head, on the connector, without removing the screw entirely from its hole. Time is thus saved and the possibility of the screw becoming lost is avoided.

Referring again to Fig. 1: A portable fuse is often inserted in the circuit leg that contains the dummy-fuse-connector so that the motor and instruments will be protected while the test is being made. Such a fuse is not always cut in; it is, however, safer to do so.

Provision is made on the connector for the attachment of one voltmeter lead. The other lead can be connected to its side of the circuit by inserting its thin metal terminal lug or its bared end between the fuse knife-blade and the corresponding contact clip.

LETTERS TO THE EDITOR.

Converter Substation Design.

To the Editor of Electrical World:

Sir:—In view of the fact that Fig. 1 in the writer's article on "American Station Practice" in the first issue in August has been observed to be similar to the design of a converter substation developed by the Brooklyn Rapid Transit Company it might be of interest to state that the actual converter station shown in the illustration in question is that of the Boston Elevated Railway Company. The section shown was prepared from a preliminary drawing made under the writer's direction as a suggested arrangement of the station and this design was accepted and adopted by the engineers of the Boston Elevated Railway Company, as it embodied their ideas as well as those of the writer.

In many respects, however, the general scheme corresponds closely with the stations of the Brooklyn Rapid Transit Company, as the rotary converters, transformers and switching

appliances in both stations were supplied by the same manufacturers and are of practically similar types. In most of the stations of the Brooklyn Rapid Transit Company, however, the converters are shunt-wound and provided with starting motors and the transformers are operated from 6600-volt circuits, while the converters of the Boston Elevated Railway Company are compound-wound and are started by means of one-third and two-third voltage taps from the step-down transformers, which are operated from 13,200-volt circuits. A careful reading of the description and examination of the cut should convince one that the design is not that of one of the stations of the Brooklyn Rapid Transit Company.

It may be a matter of interest to know the names of the other stations illustrated in the article referred to. Fig. 2 shows the original arrangement of the station of the Union Electric Light & Power Company, of St. Louis; Fig. 3 shows the Williamsburg power house of the Brooklyn Rapid Transit Company, and Fig. 4 shows the Brunots Island power house of the Pittsburgh Railways Company.

Pittsburgh, Pa. Stephen Q. Hayes.

Arc vs. Tungsten Lamps for Indirect Illumination.

To the Editor of Electrical World:

Sir:—Referring to your editorial comment in your issue of Sept. 1, 1910, of the *Electrical World*, on the digest of the article by Dr. M. Monash, in the same issue, on "Indirect Illumination with Tungsten Lamps," the writer begs permission to offer further discussion on this subject, particularly on the subject of the units employed in the tests. It will be noted that the comparative test of the relative efficiency between tungsten and arc lamps was made, in the case of both types of lamp, with an arrangement of lighting depending upon a *double reflection;* that is, the light was thrown upon a reflector and redirected from this to the ceiling. The arrangement of lamps and reflectors employed in this test, particularly with reference to the arc lamp, is one that has probably never been put into extensive practice. As already pointed out in the editorial comment on this article, any system of lighting depending for its distribution upon redirection of light from a reflector must be less efficient than the "system in which the greater portion of the light from the lamps passes directly to the ceiling."

In making a comparison of the two systems depending on the redirection of the light to the ceiling from a reflector below the lamp the smaller efficiency of the arc lamp is largely due to three things: First, to the interposition of the relatively large body of the arc lamp between the light and the ceiling; second, to the increased distance of the light from the ceiling, and, lastly, in the case especially of a direct-current arc lamp, to the direction of the light, which is in the main downward.

An examination of more recent developments in indirect lighting will show that in the case of both tungsten and arc lamps the lamps are inverted in position. In the case of a tungsten lamp, the lamp is placed in an upright position in a bowl-shaped reflector, the latter being suspended from the ceiling by chains, or placed on brackets branching out from a center rod, in the form of a chandelier. It is well known that the distribution of light from a tungsten lamp is greatest in a horizontal direction. The efficiency of the tungsten lamp in indirect lighting will, therefore, largely depend upon the proper redirection of the light from the reflector below the lamp, thus involving a considerable loss even with the most carefully designed reflector.

It was shown by Dr. Monash that an open direct-current arc lamp was found to be more economical than the tungsten lamp when the electrodes of the arc lamp were reversed, and this, apparently, with the body of the lamp (which is of considerable bulk) interposed between the light and the ceiling. It may also be assumed that the length of the arc lamp removed the light to a distance from the ceiling beyond that giving the most favorable results.

An inverted arc lamp, on the other hand, has the body of the lamp brought below the arc, giving the appearance of an ordinary arc lamp turned upside down. The arc itself is inverted and the ceiling receives the direct light of the positive carbon, which is more than 85 per cent of the total light. Consequently, there is a very small amount of "double reflection," the greater portion of the light passing directly upward to the ceiling. The value of the lower reflector becomes secondary, and while it serves to redirect the small percentage of light flux that reaches the reflector, its chief purpose will lie in its shielding the eye from the light source.

It will be observed that the horizontal distribution of the light in a tungsten lamp explains the greater efficiency of this lamp in comparison with an arc lamp which has a downward direction of light; but this horizontal distribution also accounts for the greatly decreased efficiency when comparing a tungsten lamp in either upright or downward position with an arc lamp in which the direction of the light is upward—that is, with the arc inverted.

The accumulation of dust on the reflector is one of the most important points in the comparison. Here the advantage is decidedly in favor of the inverted arc lamp, not only because the need of attention at stated intervals is more likely to provide for a periodic cleaning of the reflector, but also because the greater light flux reaches the ceiling direct and the lamp is less dependent upon the reflector than a tungsten lamp would be.

One point, however does not appear to have been brought out in the article. In determining the relative efficiency of the two kinds of lamps the rapid deterioration of the tungsten lamp should not be overlooked. The loss in efficiency due to this deterioration may be safely figured at 25 per cent to 40 per cent during the life of the lamp, and consequently the advantage is again in favor of the arc lamp. Whereas but a very slight decrease in efficiency in an arc lamp follows the accumulation of dust on the reflector and of carbon ash on the enclosing globe, the compulsory attendance required by the lamp in order to re-carbon it insures to a certain degree the cleaning of the inner globe and reflector at stated intervals, while a tungsten installation cannot be considered successful without arranging for the removal of dust accumulated on the bulb and reflector.

Philadelphia, Pa. H. Eznuk.

Digest of Current Electrical Literature

ABSTRACTS OF THE IMPORTANT ARTICLES APPEARING IN THE ELECTRICAL PERIODICAL PRESS OF THE WORLD

Generators, Motors and Transformers.

Operation in Parallel of Direct-Current Machines.—F. Punga and A. Nicolai.—A discussion of the difficulties of parallel operation of direct-current compound or over-compound machines. The conditions which should be fulfilled for perfect parallel operation are as follows: All machines must have the same characteristic curves, with the volts as ordinates and the current in per cents of full load as abscissas. The voltage drop produced in the series exciting windings by the passage of full-load current in each machine must be the same. The resistance of the equalizing (compensating) wire connecting the different machines should be as small as possible. A numerical example is added to illustrate the above principles.—*La Lumière Elec.*, Sept. 10.

High-Speed Alternators.—C. F. Guilbert.—An illustrated discussion of the considerations which govern the design of

the windings of stators of high-speed alternating-current machines. The e.m.f. in volts per turn reaches considerable values, which necessitates special care in the insulation.—*La Lumière Elec.*, Sept. 10.

Constant-Current Direct-Current Generators.—M. Osnos and L. Monath.—A critical reply to the recent paper of Rosenberg, pointing out the differences between the constant-current machines of Osnos and Rosenberg and criticising some conclusions of Rosenberg.—*Elek. Zeit.*, Sept. 15.

Rotary Converters.—E. Schulz.—An article illustrated by diagrams on the different methods of regulating the voltage of rotary converters in comparison with motor-generators.—*Elek. Anz.*, Sept. 15.

Voltage Drop of Transformers.—K. Faye-Hansen.—The author discusses various methods for determining the voltage drop of transformers and thinks the best method is the direct measurement of vectorial voltage drop at load according to Bragstadt, who connects in parallel the primaries of two identical transformers, of which one is loaded and the other unloaded. The author has used this method for testing some transformers with considerable magnetic stray fluxes and high iron saturation, especially with respect to the charge of stray flux with load. It is recommended to make similar tests with three-phase induction motors with the rotor maintained at rest.—*Elek. u. Mach.* (Vienna), Sept. 11.

Three-Phase Transformers.—K. Metzler.—An article, illustrated by diagrams, giving formulas and numerical tables for determining the dimensions of three-phase transformers.—*Elek. u. Masch.* (Vienna), Aug. 28.

Lamps and Lighting.

Drawn Tungsten Filament.—An illustrated description of a new tungsten lamp ("wotan lamp") of the Siemens & Halske Company, the principal feature of which is the use of a drawn tungsten filament. The lamp and the method of suspension

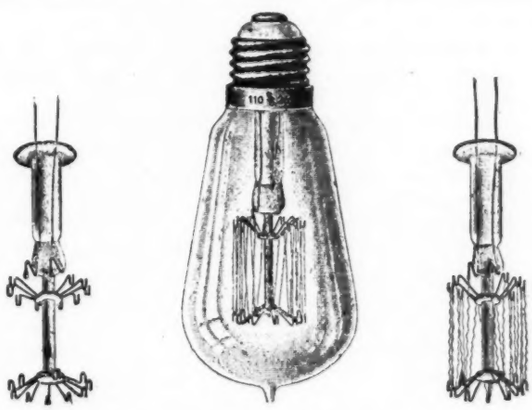


Fig. 1—Drawn Tungsten Filaments.

of the filament are shown in Fig. 1. The specific consumption is 1 watt per hefner candle. A disadvantage of this new tungsten lamp compared with the tantalum lamp is due to the fact that a drawn tungsten filament loses part of its initial elasticity on account of the passage of the current, while the tungsten filament always maintains its original strength. This new lamp is made in small sizes for operation at from 1 volt to 16 volts with dry cells, etc., and, on the other hand, in large sizes for 100 cp, 200 cp and 300 cp. At present 100-cp and 200-cp lamps are chiefly made to compete with small arc lamps.—*Elek. Anz.*, Sept. 15.

Lamp Filament.—A note on a recent British patent (18,954, 1909; Sept. 8, 1910) of H. W. Lake (Parker-Clarke Electric Company of this country). The specification covers a strong filament which can be used at a very high temperature as a lighting or heating body in the open air. A core or filament of carbon is flashed in a vessel containing a mixture of hydrogen and benzol and silicon tetrachloride. The gases are decomposed and the filament is covered with a skin of silicon-dicarbide (SiC_2). Any desired thickness of skin may be formed. Such filaments are said to incandesce in the open air without oxidizing.—Lond. *Elec. Eng'ing*, Sept. 15.

Arc Lamp.—A note on a recent British patent (29,068, 1909; Sept. 8, 1910) of H. Hirst and A. E. Angold (British General Electric Company). This is a flame-arc lamp with two converging flame carbons, one of which rests on another short, hard carbon. The arc is normally struck between the two upper electrodes, but the supporting carbon is slowly consumed by the heat due to the arc, and is fed upward by lever mechanism to keep the arc in the same position. The unsupported electrode is mechanically connected with the supported electrode and feeds down at the same rate by gravity. The specification covers the lever mechanism acting on the supporting or abutment electrode, and operated by side pressure from the electrode holder as the electrode feeds down.—Lond. *Elec. Eng'ing*, Sept. 15.

Generation, Transmission and Distribution.

Power from Wind and Sun.—R. A. Fessenden.—To utilize the energy of the wind and the sun for commercial purposes a system of storage must first be provided. The method suggested by the author is storage by gravity. Two reservoirs are constructed one at a considerable height above the other, and water is first pumped up and then allowed to flow down as desired and to actuate a turbine. To facilitate construction the higher reservoir is located on the surface of the earth and the lower reservoir underground in a shaft or mine. The author points out the advantages of water storage over storage batteries. The method of utilizing the power of the wind is very simple. A number of steel rope drives run from each of the small windmills mounted in the frame to the mainshaft, which has its bearings fastened to the frame so that when the frame is turned round to face the wind the mainshaft moves with it. The mainshaft drives the pump, the pump rod being revolvable as the axis is shifted in position. The Pelton wheel drives the generator. The Pelton wheel may also be driven directly by a rope drive from the mainshaft of the windmill, the Pelton wheel being disconnected, or left connected. To utilize solar radiation use is made of a solar tank containing water which is heated until the steam reaches approximately the pressure of the atmosphere. The steam so generated at atmospheric pressure drives a low-pressure steam turbine or a special type of engine. The turbine operates the pump. Some estimates of cost are added, and in a long editorial the scheme is discussed in its general phases.—Lond. *Electrician*, Sept. 16

Utilization of Exhaust Steam.—An illustrated description of the utilization of steam in an iron works in Newport, England. In this station exhaust steam from blast-furnace blowing engines is collected, and after being superheated is passed to exhaust-steam turbines driving alternators which are coupled up on the electrical side of the mains of an electric supply company, which transmits the energy to its consumers throughout the district. The plant consists of two 1250-kw, three-phase, 40-cycle, 6600-volt turbo-alternator sets running at 2400 r.p.m.—Lond. *Elec. Review*, Sept. 16.

Traction.

Future of Electric Traction.—W. E. Davis.—A paper read before the Central Electric Railway Association on the destinies of 500-volt direct-current, 1200-volt direct-current and 6600-volt alternating-current motors. The 500-volt direct-current system is firmly entrenched in all the largest centers of population, with every indication of becoming permanent until some revolution of power application arrives. This condition will to a great extent govern the interurban or dependent lines. New and larger railways will be built, demanding higher voltage and less losses, mechanical and electrical, and to this end the higher potential direct-current system with from 1200 volts to 2400 volts seems very favorable. In the big work of the electrification of the trunk lines of the steam railways the single-phase system will find its own. It is noted that the comparative freedom from trouble on the Chicago, Lake Shore & South Bend Railway is probably due largely to the fact that the system is entirely alternating current at 6600 volts, with no

direct-current or low-voltage complications.—*Elec. Ry. Jour.*, Sept. 24.

Single-Phase Traction.—An editorial discussion of the decision of the New Haven railroad to adopt the single-phase system on the Hoosac Tunnel division and on its New York, Westchester & Boston line. The most important feature of all the new electrification work of the company is that it will be single-phase without direct-current complication, so that the equipment should be very much simpler and capable of very much better work than even the present equipment on the main line of the New Haven road. This decision not only guarantees an extended application of the single-phase system to trunk-line service, but it indicates that the results with the present system have been so satisfactory as to warrant its extension.—*Elec. Ry. Jour.*, Sept. 24.

Installations, Systems and Appliances.

Tariff for Municipal Central Stations.—K. Gajczak.—The author thinks it wrong that a tariff for charging for electrical energy should be devised from the standpoint of the central-station manager. He thinks it should be based on the viewpoint of the consumer. Such a rate should be charged to each consumer that it would not pay him to generate the energy himself. The author gives various tables showing the cost of generating energy. He recommends a maximum rate of 5 cents per kw-hour.—*Elek. u. Masch.* (Vienna), Aug. 21.

Rheostats.—H. Hecke.—An illustrated description of a new form of resistor units for rheostats. Each unit consists of a coil of wire wound on a metallic tube so that the heat is quickly carried away. Water cooling may be employed. The metallic tube is insulated by a thin layer of refractory porcelain enamel. For the resistor use is made of manganin wire, the surface of which is easily covered with a very thin film of oxide which is sufficient for insulation.—*Elek. Anz.*, Sept. 4.

Wires, Wiring and Conduits.

Temperature Coefficients of Electrical Resistances.—A. A. Somerville.—A continuation of his extended researches on the change of electrical resistance with temperature of various materials. The materials tested are aluminum, silver, iron, copper, gold, manganin, constantan, "advance," porcelain, quartz, mica, glass, carbon, "excello," "ia ia," "superior" and magnesium. The temperature range is from 0 deg. C. to 1100 deg. C., or to the melting point of the specimen. With copper the results depend on whether the wire is hard-drawn or how well it is annealed. Modern electrolytic copper behaves differently from the purest copper made twenty-five years ago. The effect of cold drawing and annealing is more noticeable in gold. The results found for the different materials are given in a series of diagrams and tables. Fig. 2 gives the results for copper

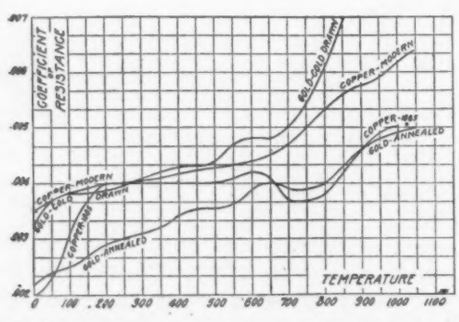


Fig. 2—Temperature Coefficients of Electrical Resistances.

and gold, the temperature coefficients, that is, the slope of the temperature-resistance curves, being plotted against temperature.—*Phys. Rev.*, September.

Insulation.—A. O. Austin.—A paper read before the Central Electric Railway Association on the design and efficiency of high-tension insulators. The article is illustrated by various diagrams giving the relation between the diameter and surface resistance of insulators and weight and cost curves of pin and suspension insulators.—*Elec. Ry. Jour.*, Sept. 24.

Underground Cables.—R. E. Neale.—Some notes on high-tension underground mains, referring especially to the methods of laying underground cables, the life and cause of breakdown of underground cables, and the limiting and the test voltages.—Lond. *Elec. Review*, Sept. 16.

Electrophysics and Magnetism.

Laws of Electromechanics.—S. P. Thompson.—A paper presented before the British association giving a concise mathematical statement of the six fundamental laws of electromechanics, namely, the law of the magnetic circuit, the law of induction (Faraday), the law of electric power, the law of work, the law of change of flux, and the law of force.—Lond. *Electrician*, Sept. 16.

Radium.—Mme. P. Curie and A. Debierne.—A description of their experiments in which they separated metallic radium. The principle of the method consists in preparing a radium amalgam and in expelling the mercury by distillation under favorable conditions. The amalgam was obtained by the electrolysis of a perfectly pure solution of radium chloride.—Lond. *Electrician*, Sept. 16.

Spark Discharge at Very Small Distances.—E. H. Williams. An account of an experimental investigation, the results of which are summed up as follows: The material of which the electrodes are made has no effect upon the discharge potential. The nature of the discharge for very short distances is the same as for greater distances. The discharge potential for a distance between the electrodes of one wave-length of sodium light is the same as for five wave-lengths, being in both cases the minimum potential, which is 372 volts. When the distance between the electrodes is very short, 5λ or less, the path of the discharge is not along the shortest distance. Ionization of the gas between the electrodes lowers the discharge potential. The electric force in a beam of ultra-violet light is, according to the wave theory, 0.5 volt per centimeter; yet the beam of light is able to produce an action which cannot be brought about by a constant electrostatic force of 5×10^6 volts per centimeter. This fact points to a modification of the wave theory as suggested by the electromagnetic emission of the theory of light. The nature of the dielectric affects the discharge potential—the presence of moisture lowering this potential. For dry air the minimum potential is 372 volts whether the distance between the electrods is 1λ or 5λ.—*Phys. Rev.*, September.

The Linear Electrical Oscillator.—James E. Ives.—An account of an experimental determination of the wave-length and logarithmic decrement of the linear electric oscillator with the interferometer. The wave-length of the linear oscillator is slightly greater than twice its length. The ratio of wave-length to length of oscillator was found to be 2.03, 2.04, 2.08 for the 10-cm, 7.5-cm and 5-cm oscillators, respectively. The logarithmic decrement was found to be of the same order as that given by Abraham's formula. For the same length or spark-gap the total decrement decreases as the length of the oscillator increases.—*Phys. Rev.*, September.

Magnetic Alloys from Non-Magnetic Metals.—E. B. Stephenson.—An experimental investigation of Heusler alloys, composed of copper, manganese and aluminum. The most magnetic specimens have the manganese and aluminum in appproximately the proportions of their atomic weights. Heating to various temperatures, cooling in air and testing at room temperatures gave for $H = 50$ a permeability-temperature curve with a slight minimum near 250 deg., a very pronounced minimum between 600 deg. and 700 deg., and a rise to higher than the original value at 900 deg. This series of changes are reversible for at least three times. The largest value of induction was obtained when the specimen was quenched in water from near its melting point. A series of cooling curves gave melting points between 910 deg. and 970 deg., and curves characteristic of solid solutions. The cooling curves for the two magnetic specimens showed transformation points with evolution of heat at 615 deg. Specimens cooled in air from this temperature are non-magnetic at room temperature. It seems evident that there is an allotropic form of the alloy which has a practically non-magnetic molecular arrangement. A series of photomicrographs showed differences in crystalline structure

due to thermal treatment, but no certain relation could be established between the magnetic properties and crystalline structure.—*Phys. Rev.*, September.

Electrochemistry and Batteries.

Electric Steel Making.—H. Thieme.—The conclusion of his detailed illustrated description of the electric-furnace plant in Dommeldingen, Luxemburg. Besides two single-phase furnaces it contains a 1.5-ton three-phase furnace. All these are "combination furnaces," being heated partly by induction and partly by direct-resistance heating by means of pole plates. The molten pig iron is supplied to the furnaces from a 20-ton mixer. It is intended to enlarge the plant for a production of from 70 tons to 80 tons of electric steel per day.—*Elek. Zeit.*, Sept. 15.

Units, Measurements and Instruments.

Photographic Photometry.—C. F. Brush.—The author states that photographic photometry may safely and usefully be employed for detecting and estimating moderate and small changes in light down to amounts considerably less than 1 per cent of the whole. Fig. 3 is a diagram of the apparatus employed. An incandescent electric lamp *h*, with heavily frosted bulb, is mounted in a well-ventilated box or lantern *i* adapted to be moved horizontally on a long bar *k*. Close to the surface of the lamp bulb is an iris diaphragm *l* controlling the diameter of a circular spot on the surface of the bulb, which spot is the source of light used in most parts of the experiments. A large, thick wooden screen *n* has an opening *o*, 5 mm high and 19 mm long, horizontally, with semicircular ends. A beam of light from *h* passes through the opening *o* and falls on a photographic plate *p* carried in a holder which may be quickly secured in any one of eighteen definite positions, as shown at *t*,

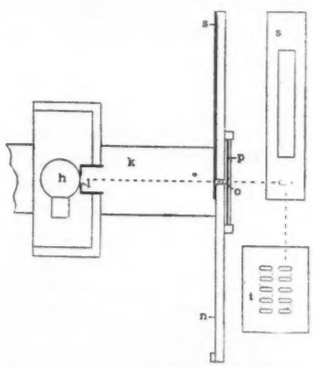


Fig. 3—Photographic Photometry.

which is a front view of the plate. The opening *o* is closed normally by a drop-shutter *s* of thick sheet metal. A front view of this shutter, at the right, shows in dotted line the opening *o* behind it. The shutter moves with perfect freedom in vertical guides, and is retained in its upper position by a spring catch, which may be released at pleasure. The slot in the shutter is of such length as to give a mean exposure of one-ninth second. Of course, the lower part of the spot of light through *o* is exposed less than the upper part, on account of the different speed of the shutter in opening and closing *o*. The difference is found by calculation to be about 2 per cent. It is corrected by vertical adjustment of the lamp. Experience shows that this shutter may be relied on to give constant exposures. A screen, not shown, covers the opening *o* while the shutter is being raised. The lamp *h* is supplied with current from a large storage battery. The optical system or body the transparency of which is to be tested is placed in the path of the beam of light from *l* to *o*. The customary manner of using this apparatus is to expose one or two rows of five spots each on the photographic plate, as shown, in full lines at *t*, with four blank alternating spaces between them. These spots are termed "comparison spots," and are used as a standard with which to compare the intermediate spots shown in dotted lines, and exposed subsequently, after the introduction, removal or change of the optical system in the path of the light. Details of the photographic apparatus and methods applied are given, and some interesting photographic phenomena are described.—*Phys. Rev.*, September.

Measuring Heat Conductivity.—F. Bacon.—A paper read before the British association on a method of testing heat-insulating materials. The method consists in measuring the drop of temperature between the two faces of a thin slab transmitting a known heat flux. Duplicate specimens of the material to be tested are obtained in the form of slabs measuring 18 in. x 18 in. and not more than 1.5 in. thick. A thin, flat heating net of uniformly wound resistance wire, interwoven with asbestos, measuring 12 in. x 12 in., is sandwiched in between these slabs, the marginal crack left all round the heating net being filled with strips of felt. Direct contact between the heating net and slabs of insulating material is avoided by interposing a thin sheet of asbestos millboard on each side. To measure the temperature of the faces of the slabs advantage is taken of the fact that there is no perceptible drop of temperature between the heat-insulator and a good conductor of heat in close contact with it. Sheets of zinc 12 in. x 12 in. are taken, and a flat resistance coil of fine double silk-covered wire wound uniformly over a central 6 in. square of one of their faces. The wire is wound non-inductively and secured to the zinc plates by stitches of thread passing through fine holes drilled in the metal. Zinc plates prepared in this way are inserted on each side of the slabs of insulation, the fine wire coils being in direct contact with the material to be tested. Thin wood covers are now put on both sides, and the whole is clamped firmly together by four bolts, with wing nuts passing through two skeleton frames of wood (Fig. 4). The apparatus is then hung in a vertical plane in a situation screened from drafts and sunlight. The terminals of the heating net are led away through a resistor of an adjustable resistance and suitable switchgear to a battery of accumulators. A voltmeter and ammeter are connected up to the circuit, from the readings of which the watts dissipated can be ascertained. As

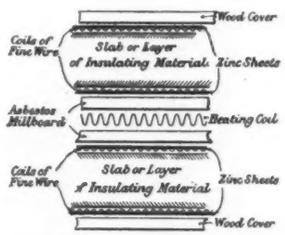


Fig. 4—Measuring Heat Conductivity.

the arrangement of slabs is identical on both sides of the heating net, the heat generated will divide equally, half escaping through one wall and half through the other. The terminals of the resistor of fine copper wire are connected to a Wheatstone bridge of the stretched-wire type through a system of plugs, which enables the ratio of resistances of either pair of coils to be determined. By assuming a value for the temperature-resistance coefficient of the copper wire, of which the coils are wound, the excess of temperature of the inner over the outer faces of the insulating material can be immediately determined. The system of plugs also allows of the resistance of any one of the four coils being compared with that of a fifth coil situated in the unheated surrounding air, the temperature of which is measured with an ordinary thermometer. This arrangement enables the absolute temperature at the inside or outside of either of the slabs to be determined. Since the coils which give the temperature of the faces measure only 6 in. x 6 in., while the heating net measures 12 in. x 12 in., there is a marginal guard ring of heat flux of 3 in. wide all round the central area, through which the heat gradient is determined. The chief results are given in the following table. The conductivities are given in kilogram-calories passing per hour through a cross-section of 1 sq. m when the temperature gradient is 1 deg. C. per meter. To convert the conductivities into lb.-Fahr. heat units per square foot per hour for a tem-

perature gradient of 1 deg. Fahr, per inch the figures given in the table must be multiplied by 8.05. Thus for yellow pine, $0.13 \times 8.05 = 1.04$. As to the uses of silicate cotton the results show:

Material	Spec. Grav.	Coeff. of Heat Conductivity at 50° C. to 75° C.
Yellow pine across grain	0.360	0.13
Teak across grain	0.515	0.23
Expansit Schrot No. 1*	0.051	0.055
Expansit Schrot No. 2*	0.049	0.061
Compressed cork slabs	0.166	0.060
Silicate cotton or slag wool	0.330 0.256 0.141 0.113	mean value 0.07
Asbestos sheet, ½ in. thick	1.240	0.25
Millboard, ⅛ in. thick	1.075	0.14 to 0.1
Air jacket in the vertical plane 1 in. wide, walls of asbestos millboard		0.26 to 0.31

*A special preparation of cork.

Experiments with silicate cotton show that loose packing makes slightly the best insulator for small differences of temperature, but firm packing is much the best when the temperature difference is considerable. On the whole, the results indicate that it is advisable to pack the silicate cotton as firmly as possible, especially as this ensures that the material will not afterward subside so as to leave holes which cannot afterward be filled. Results for asbestos lead to the conclusion that its value as a heat insulator is due rather to its fireproof qualities than to its low conductivity, which, indeed, appears to be no lower than the conductivity of wood.—Lond. *Electrician*, Sept. 16.

Mechanical Hysteresis of Rubber.—A. Schwartz.—An abstract of a paper read before the British association on a machine for testing rubber by means of its mechanical hysteresis. The principle of the machine is indicated in the left-

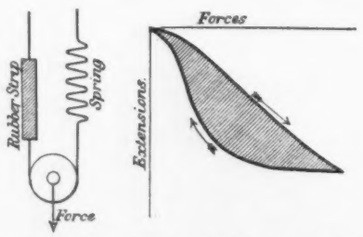


Fig. 5—Mechanical Hysteresis of Rubber.

hand diagram of Fig. 5. The strip of rubber to be tested, usually measuring ⅜ in. x 1/10 in. x 4 in. long, is connected, by a flexible cord passing round a pulley, with a spring-balance as indicated. The upper ends of both the rubber test-piece and the spring are connected, the one to a drum and the other to the pencil of a recording gear. The load is applied to the specimen by pulling down the pulley, and it is seen that from the arrangement of the apparatus the pull on the test-piece and the pull on the spring are equal, though the corresponding extensions are different. The diagram obtained in a cycle comprising the gradual loading of the specimen and the gradual removal of the load has the character indicated in the right-hand diagram. On repeating the cycle the area of the hysteresis curve increases, the maximum extension under the same maximum load being greater. However, with high-grade rubber the area of the hysteresis diagram becomes practically constant after the sixth repetition of the cycle. The discussion was opened by Professor Fessenden, who said that the determination of the hysteresis diagram constitutes a fairly good method of testing the quality of rubber. He has, however, found that for the same quality of rubber the amount of hysteresis is dependent on the character of the adulterant or admixture employed. Rubber, he continued, has very peculiar mechanical properties, due, as was originally pointed out by Faraday, to the circumstances that the gum is an aggregate of two substances—one horny and the other plastic— and to this is also due the unusual value of Poisson's ratio for the material. The mechanical properties of rubber can be simulated by imagining a series of spheres of copper connected together at their points of contact and filled with water. Such an aggregate would take a large extension under a tensile force, the spheres deforming into ellipsoids and compressing the contained fluid. If such a system were heated while under tension it would contract, owing to the expansion of the water tending to restore the deformed spheres to their original form. Such a system has also a large mechanical hysteresis. The heat generated on compression must leak out, and by using a good conductor for the admixture, in the case of india-rubber, its hysteresis is decreased and the rubber will in consequence last longer in service.—Lond. *Eng'ing*, Sept. 16.

Electricity Meters.—An illustrated description of various recent improvements in the design of electricity meters. A method of compensating friction is illustrated in Fig. 6, where

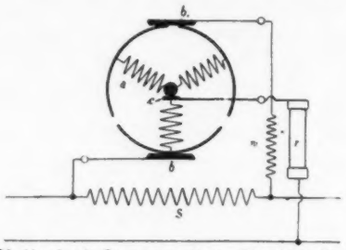


Fig. 6—Method of Compensating Friction in Meters.

a is the armature of the meter. Part of the current to be measured is supplied to the meter through the brushes b and b_1 in parallel with the shunt s in one main conductor. c is a third brush which is connected in series with the resistor r to the other main conductor. There is not only the current through the armature due to the potential difference at the terminals of the shunt s, but there is also another almost constant current in the armature which exerts no torque if the resistance w is zero, since in this case the positive and negative torques balance each other. If, however, the resistance w is inserted, the second current divides itself in the armature in a non-symmetric manner and there results a positive torque which compensates the friction. The resistance of the series resistor r is very large, from 50,000 ohms to 100,000 ohms per 100 volts, and the resistor is therefore made of carbon or graphite. Several new constructions of the form of the iron core in alternating-current induction meters and the combination of a meter with a maximum-demand indicator are also described.—*Elek. Anz.*, Sept. 15.

Telegraphy, Telephony and Signals.

Wireless Telegraphy in Japan.—Wichi Torikata.—The author first gives data on the Teishinsho system, which is a spark system as regards its transmitter, and makes use of a telephone and detector for its receiver. Many special devices are used to minimize the damping and get sharp tuning. Of detectors the Teppun, the tantalum and the Koseki are chiefly used. In the Teppun detector two steel poles are magnetized and arranged to be adjustable in their distance as in a coherer. Fine steel powder, oxidized on its surface by burning in a flame, is introduced between the poles so that the powder makes a bridge between them by the magnetic field of the poles. The powder must not be in too great a quantity, and each granule must be neither too large nor too small. The sensibility of the detector depends mainly upon the degree of the oxidation and also upon the adjustment. The tantalum detector of the author depends upon dipping a tantalum point into some alkaline or acid solution. The Koseki detector employs zincite, molybdenite or iron pyrite as a substitute for the oxidized iron-powder of the Teppun detector.—Lond. *Electrician*, Sept. 16.

Miscellaneous.

Diseases of Electrical Workingmen.—W. Hanauer.—The principal "professional" diseases of electrical workingmen are diseases of the respiration organs, heart disease, rheumatism and eye diseases. Poisoning, skin diseases and nervous troubles are not rare. Burnings and accidents due to high-tension currents are also discussed.—*Elek. Zeit.*, Sept. 8.

Book Review.

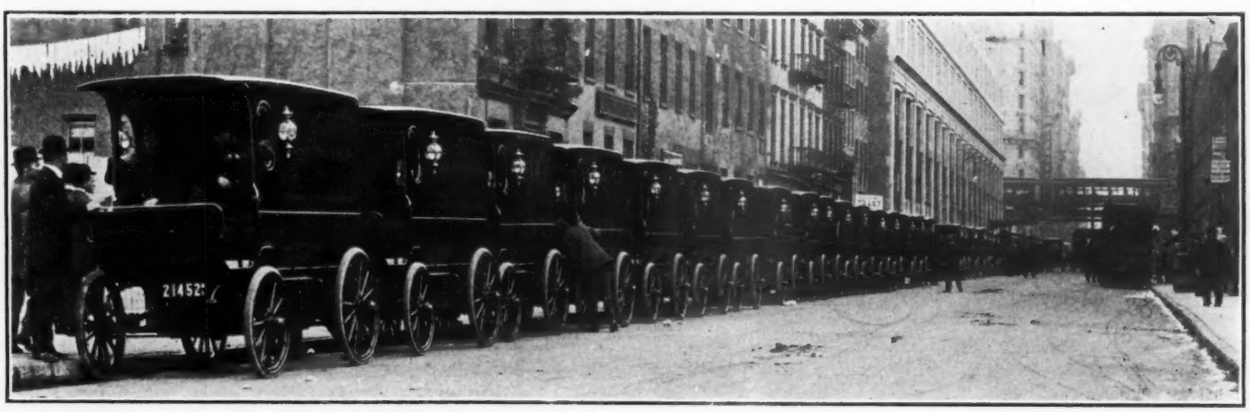
Hand-Book for Steam Engineers and Electricians. By Calvin F. Swingle. Chicago: Frederick J. Drake & Company. 1500 pages. 696 illus. Price, $3.

Although this is a new book in that its name is changed, actually it is the third edition of the author's hand-book for steam engineers, revised and greatly enlarged. This book may be likened to an intelligently prepared catalog of steam, gas and air apparatus, with some theory and a considerable amount of operating instructions. The different commercial types of boilers, stokers, feed-water heaters, steam turbines, gas engines and other apparatus are described in considerable detail. The steam engine being a more standard piece of apparatus, is treated in a general way by describing types and giving details of valve motions and instructions for setting them. The chapters on indicators, indicator card analysis, boiler operation and lubrication are among the most useful to operating engineers in general, while the chapters on air machinery and elevators will be of special interest to engineers in certain classes of isolated plants. An electrical section has been added to this edition. An attempt is made to give the reader some notion of the underlying principles of electricity, but here even more than in other parts of the book the reader will derive most from the questions and answers which follow the chapters.

New Apparatus and Appliances

LARGE EQUIPMENT OF ELECTRIC AUTOMOBILES FOR NEW YORK DEPARTMENT STORE.

The complete equipment of Gimbel Brothers' New York department store in its delivery department with automobiles, to the exclusion of horses, marks an epoch which expresses the absolute confidence of the modern merchants in the superior economy and efficiency of machine transportation. Few single installations have had concentrated upon them the degree of investigation, forethought and detail consideration given to the one in question. Sufficiently far in advance of the requirements for service of these machines the whole problem, with all of its complicated phases, was completely digested and the conclusion reached that for the delivery of goods and the handling of incoming merchandise covering the entire district of Greater New York and the adjacent territory in New Jersey, on Long Island and through the residential districts along Long Island Sound and the Hudson River the electric vehicle represented the best economy; and as a result this type of vehicle constitutes almost the entire equipment with the exception of some five gasoline transfer trucks for service between the main store and the outlying distribution substations, together with five gasoline package-delivery machines for service over the far suburban districts where the deliveries are scattered, or in sections where the infrequency of delivery requirements does not warrant the regular service of a route wagon.



Electric Automobiles of Gimbel Brothers' New York Department Store.

Sixty-six Studebaker machines went into immediate service at the opening of the store last week. Twelve or fifteen additional will be in service by the Christmas holidays, and it is expected that the equipment will amount to 150 machines early in the coming year, concurrent with the development of the business. The sixty-six machines include thirty-eight "package-delivery" panel-type vehicles, ten "bulk" delivery panel machines of approximately 1-ton capacity, seven screen-side 1-ton machines for the delivery of household equipment, and two machines of the same size specially adapted for furniture delivery service. The service of both the latter type machines is supplemented by two screen-side machines and four machines for furniture delivery of a larger carrying capacity, and there are three freight trucks for the handling of incoming and outgoing freight, as well as for store to warehouse service.

The central garage for the operation, care and maintenance of these machines is located on Twenty-fourth Street west of Tenth Avenue, and is a specially constructed fireproof structure with a 150-ft. frontage and a depth from front to rear of 100 ft. This garage is equipped with the most modern devices which specialized engineering in this direction could provide, and it is confidently expected that the record system and other advanced details of management will characterize this installation as one of the foremost in verifying the predetermined accuracy and economy with which electric vehicles may be operated.

The electric service is provided by the New York Edison Company from an adjacent transformer substation and is delivered to the building in four circuits, as follows: One direct-current charging circuit at 120 volts, one direct-current charging circuit at 75 volts, one alternating-current lighting circuit and one alternating-current motor circuit for the operation of elevators and mechanical equipment. The switchboard occupies a space 30 ft. long and is located on a raised platform so as to give the operator a commanding view of the entire lower floor, and this switchboard is divided into thirteen panels, each controlling six charging stations, with provision for an extension to a total of 130 charging points within this building. The switchboard operator also controls a recording station equipped with the necessary instruments, time clocks, card-index system and other apparatus, providing for a complete and accurate registration of the entire station and the performance of each individual machine.

The charging cables are led from this switchboard in metal

conduit to each of the charging stations, where they terminate in the charging plug for connection to the machine batteries, and the control of the charging function is completely under command of the switchboard operator, a signal system being installed, paralleling each of these charging cables, so that the operator is automatically made aware of the condition of each of the batteries undergoing charge. This function is largely rendered possible by the use of specially designed amp-hour meters and recording devices with which each of the machines is equipped, and such records will be kept as will indicate the periodic mileage of the vehicles, as well as the life or service of the batteries and tires and such other data as will afford the means of recording the performance by the vehicle and the life of each part of the equipment in terms of electrical energy units. This means that the cost of operation will be eventually determined in relation to the energy consumed by the machines in the daily performance of their work, so that knowing the kw-hours required to do certain work and cost of tires, batteries, etc., per kw-hour, the entire cost of any similar work may be determined by measuring the kw-hours required for such work.

Among the structural features of this garage building are three 12-ft. entrances from the street, which provide access to the corresponding bays on the ground floor, which are separated from each other by means of a slightly raised concrete bumper against which the front ends of the vehicles rest; the flexible charging cable suspended from the ceiling being inserted in the charging receptacle located at the front of the machine. This arrangement permits easy access to the motor equipment at the rear of the vehicles, which are consequently adjacent to the wide aisle between each row of machines.

Located at one end of the building is an elevator with a platform 10 ft. x 20 ft., having a carrying capacity of 10 000 lb., with a direct opening onto the street at the sidewalk, thus avoiding the necessity of machines intended for the second floor entering the building except by means of this elevator. At the opposite end of the ground floor are located the superintendent's office, storeroom for packages, lavatories, lubricating-oil vault and a gasoline pump vault communicating with four gasoline tanks of 275 gal. each located under the sidewalk.

At the rear of the ground floor are three washstands, each 15 ft. x 20 ft., provided with hot and cold water, illuminated at night by electric light and in the daytime from an 8-ft. wide skylight running the entire length of the rear, which lighting effect is accomplished by offsetting inward the second-story rear wall to this amount.

The second floor has two stairway communications from the ground floor in addition to the elevator and is equipped with unusual facilities for the adequate care and maintenance of machines. There is a battery-room, 38 ft. x 50 ft., for the formation and repair of batteries, supplied with energy from its own switchboard, having six outlets and recording and testing instruments to insure unusual accuracy. An enclosed varnish-room, 25 ft. x 25 ft., provides for the periodic repainting of the machines so that they may constantly present an attractive appearance.

The machine shop, 25 ft. x 50 ft., has an equipment of machine tools which is likely to meet any emergency which may arise from collision, accident or normal wear and tear. A washstand, 25 ft. x 35 ft., amply illuminated, provides for the cleansing of such machines as may be stored on this floor independent of the facilities on the floor below. Adequate provisions are made for the comfort of chauffeurs as inducement toward self-respect and *esprit de corps*. These are a tailor shop, in which their uniforms and clothing may be kept in condition; a lounging-room fitted with an equipment likely to stimulate interest in their work; a locker-room for the preservation of their clothing, and a lavatory and washroom fitted with shower bath and similar comforts.

The entire building is heated by steam and provided with an ample supply of warm water for the washing of vehicles in the winter season. In order to comply with insurance regulations the blacksmith shop is located on the roof in such a manner as not to communicate with the rest of the building.

In the Bronx and at Newark, N. J., are located two substations, the former being 50 ft. x 100 ft. and the latter 100 ft. square, each capable of caring for twenty-four machines. These are well lighted and heated and equipped with vehicle-washing facilities, gasoline storage tanks and charging equipment supplied from alternating-current service by means of mercury-arc rectifiers. These two substations will be later supplemented with others located on Long Island and probably at New Rochelle.

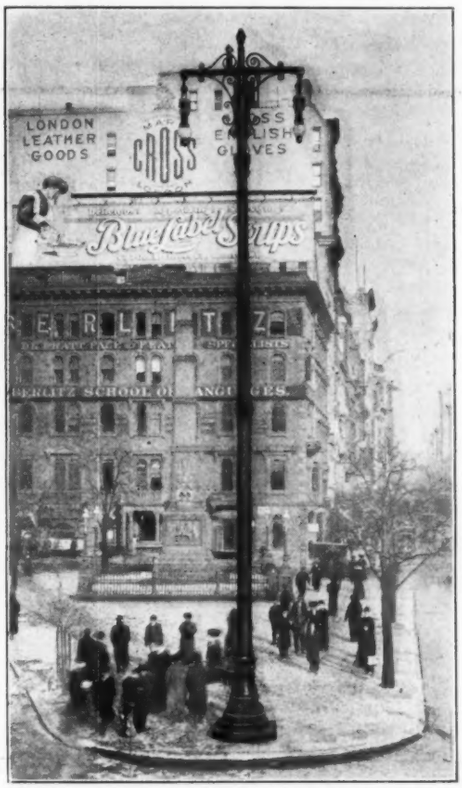
This entire delivery outfit has been installed with the idea of reducing operating cost to the lowest possible minimum, the cost of operation being figured at less than $1,000 per annum, to include perpetuation of the equipment, the interest on the investment, up-keep of the machines, superintendent's salary, labor and electricity. Among the features of the machines indicating the very latest developments are 42-in. driving wheels to reduce tire wear and energy consumption as well as lessen jolting or vibration; independent or auxiliary spring suspension of the battery equipment to preserve the battery plates; 3-in. bridge jars to reduce or eliminate battery cleaning; standard railway waste-box method of lubrication to insure protection of bearings with the least human effort; "odometers" to record the mileage and the tire life, and Sangamo amp-hour meters to indicate the state of charge in the battery and record the total life of the battery plates in amp-hour output.

By agreement the operation of this installation for a number of years will be under the supervision and direction of the engineering department of the Studebaker Company. This provision was made with the interests of both the manufacturer and the user in view, and to provide against any possible misapplication of the machines or unwarranted cost of operation. Arrangements are being made to furnish similar automobile service for the Philadelphia and Milwaukee stores of the Gimbel Brothers.

FLAMING ARCS FOR ILLUMINATING PUBLIC SQUARES IN NEW YORK CITY.

The Department of Water Supply, Gas and Electricity of New York City has been experimenting for some time with various types of flaming-arc lamps for illuminating large public squares. The ordinary enclosed-arc lamps are unsuited for this purpose because the area to be illuminated is too large and it is not desirable to erect numerous posts in the roadway, which would interfere with vehicular traffic. At Times Square, Madison Square, the Plaza and one or two other locations the New York Edison Company has erected 50-ft. poles which support two flaming-arc lamps of the Blondel type, as shown in the accompanying illustration. The lamps used are manufactured by the Charles L. Kiewert Company, of New York, Milwaukee and San Francisco, and are connected two in series across the Edison direct-current mains. The Kiewert company's "Alba" lamp is used because its voluminous vertical flame is adapted for uniform illumination of large areas. As is well known, the distinctive feature of the "Alba" flaming-arc lamp is the vertical arrangement of the electrodes, which possess a large chemical core. The positive as well as the negative electrode has merely a very thin covering of ordinary carbon material serving as a case for the core of impregnating material. The light has a pure white and soft color and the electrodes are short and self-focusing; that is, the positive and negative both feed thus maintaining the position of the arc in the economizer. The lamps employed consume 12 amp at 40 volts. An ash tray controls the amount of air admitted to the globe and directs its course so that it sweeps the metal oxides out of the globe with it. In the "Alba" lamp the differential horseshoe-type magnets are both vertically arranged. Between them moves a soft-iron armature which is attached to a swinging frame containing the regulating mechanism. The armature being under the joint influence of the series and shunt magnet always moves to the stronger one. When the lamp is switched into circuit, the shunt magnet attracts the armature and by this movement of the swinging frame the sensitive anchor escape-

ment is released and the electrodes feed slowly together. After they touch each other the series magnet pulls the armature its way, which movement locks the feeding mechanism so that the proper arc length is obtained. The intervals of feed are very



Flaming-Arc Lamps, Madison Square, New York.

small and the arc distance practically does not vary. The lamp is also built for operating on alternating-current circuits. The manufacturer claims 2800 mean hemispherical candle-power, with electrodes giving a white flame.

MOTOR-DRIVEN CUTTING AND TRIMMING TABLE.

The accompanying illustration shows a motor-driven cutting and trimming table, arranged with a light-proof box for blue-print paper. This trimming table will be found of very great convenience and utility to all makers of blue prints, and it can also be used to excellent advantage for cutting tracing paper or cloth, detail paper, etc. This table is provided with a parallel clamp, operated with a foot treadle which holds the paper, tracing cloth or print securely while the revolving cutting knife is used. This device is very rapid and convenient in operation, and will trim a very narrow strip from the paper or print.

The revolving cutting knife is motor-driven, and is rotated positively by mechanical means not depending upon the friction against the blade or paper, and therefore will cut the thinnest paper and will also cut five to ten sheets at once. The knife is electrically operated in either direction at will, being stopped or started at any point by a specially designed wrist-controlled switch which leaves both hands of the operator free to handle the paper or prints. The table is constructed of hard wood with metal trimmings, arranged to be easily knocked down for shipment. The electrical equipment is complete and arranged so it can be fed from any incandescent light socket. The top of the table is scored in inches, and is provided with figures along the front edge, so that any size sheet can be instantly cut. A sizing diagram can also be provided for the top of the table, which gives at a glance the size of any tracing or print and the square foot measurement, no calculation being necessary. The tables are also furnished with a basket on the end, instead of a light-proof box, especially designed for cutting prints after they have been run in an automatic continuous printing, washing and drying equipment. The tables as regularly furnished are 4 ft. wide by 6 ft. long, but any width table up to 8 ft. wide can be supplied. This table is also furnished

Motor-Driven Trimming and Cutting Table.

in widths up to 42 in. wide, arranged for operating the cutting knife by hand instead of with motor. The cutting machinery is all self-contained, and can be furnished separately if desired, so it can be bolted on any table of appropriate width, and the cutting device can be used with or without the parallel clamp as desired. The apparatus is manufactured by the C. F. Pease Company, 167 Adams Street, Chicago, Ill.

A 100-HOUR FLAMING ARC LAMP.

Excessive maintenance charges because of frequent trimming has been a complaint against the flaming-arc lamp, for, as is well known, despite the long, fragile electrodes employed in most of these lamps, the number of hours burning per trim is very much less than is obtained from the ordinary enclosed-arc lamp. Fox Brothers & Company, of New York City, have just introduced a flaming-arc lamp which is guaranteed to burn 100 hours per trim and to yield approximately 3400 cp on a power consumption of 550 watts when operated two in series across 110-volt circuits. The "Multax Century" lamp is asserted to be as simple as the ordinary open-arc lamp, the electrodes feeding in a self-controlled manner with an entire absence of clockwork, escapement wheels, chains, cables, etc., and without any stop or rest in the arc chamber. The lamp operates on the differential principle and the position of the electrode tips is said to be fixed in the arc chamber at all times. When placed in circuit the shunt solenoids operate a slipper block, causing the electrodes to strike together. When this function is performed the series solenoids cause the slipper block to separate the electrodes, thus establishing and maintaining the arc at a constant value. The electrodes are arranged side by side and are inclined to form a "V" so that the arc is maintained across the lower extremities by the passage of the energy. The secret of the long life is found in the electrodes, which are of the bridge-core type, consisting of an outer zone of hard carbon of a high degree of purity and a central core of mineral salts, as shown in Fig. 2. The salts are proportioned to give a volume of rich yellow or white light. The electrodes are not of the fragile type and are quite broad, it being understood that the lamp is approximately 3.5 ft. long over-all and that two electrodes burn 100 hours. Instead of the porcelain economizer, a metal economizer is placed over and around the arc, serving not only as a protection from the heat of the arc, but also as a reflector to throw the light downward. The white deposit from the electrodes is said to keep the reflecting surface in perfect condition throughout the entire burning hours of the lamp. Each lamp is equipped with an opalescent globe provided with suitable ventilating arrangements and fitted so that the company's patent light deflector may be placed in the globe to increase the horizontal distribution, if so desired. The cases are finished in a deep sea-green enamel with brass perimeters around the case collar and around the collar of the top cap enclosing the upper chamber. The lamp weighs approximately 42 lb.

The company is also bringing out a fifty-hour lamp called

"Multax Fifty," which is approximately 2.75 ft. long and weighs 36 lb. This lamp does not differ materially in construction from the 100-hour lamp. Both lamps are designed for

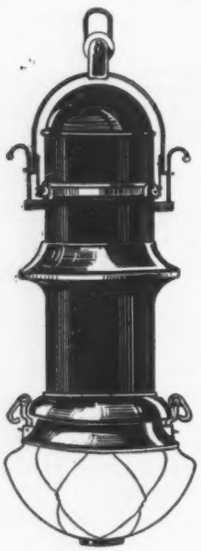


Fig. 1—100-Hour Flaming-Arc Lamp.

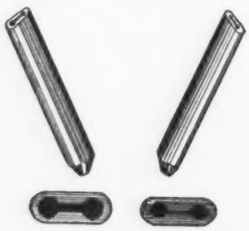


Fig. 2—Bridge-Core Type of Carbons.

operation on direct-current or alternating-current circuits and when connected in series on 240-volt or 550-volt direct-current circuits are equipped with an automatic cut-out arranged to cut into the circuit a compensating resistance, so that when the lamp is not burning from any cause whatever the other lamps in the circuit operate normally. These resistances are self-contained within the lamp casing. The claim is made that any electrician can handle and install the lamps.

ROTARY PUMP FOR AUTOMATIC HOUSEHOLD WATER SUPPLY.

A house-service pump employing the principle of the von Pittler positive, rotary pump, which has been in use in Germany for several years, is now being introduced into this country, and as applied to motor-driven household water-supply systems presents such obvious advantages in use as the avoidance of water-storage or compressed-air tanks, the delivery of water fresh from the source of supply, energy consumption proportional to a pumping lift only to the height of demand, and the combination of an efficient and compact high-speed motor with a rotary, piston-principle pump delivering continuous output.

The pump itself consists of a rotating solid-bronze cylinder having its surface crossed by transverse rectangular slots in which movable vanes are free to slide (at right angles to the direction of rotation) as propelled by the cam surfaces in the stationary side pieces between which the moving cylinder rotates. This arrangement will be clear from the accompanying diagram, which represents a development of these cylindrical parts rolled out into the plane surface of the page. This shows the central rotating part in which the vanes slide, actuated by the cam surfaces in the outer stationary parts. At the points indicated inlet and discharge ports open into the piston chambers from the outside cylindrical casing. The work of pumping is done, however, between *II* and *III*, as indicated, the vanes being maintained stationary while under pressure. There is accordingly no movement of the vanes except under balanced pressures, avoiding heavy friction, which would rapidly wear the parts. Wear on the ends of the vanes against the cam surfaces can be compensated for by splitting the vanes into two halves, and admitting pressure from the delivery side of the pump through a circumferential channel in the pump cylinder, thus holding the vane parts out against the cam surfaces at all times. Since two vanes are always moving through the pumping chambers the action may be compared to that of a cylinder of infinite length, with a piston moving through it forcing the water ahead at constant speed, without spurts or vibrations. This continuous delivery pressure is less severe on pipes and hose and reduces friction. The superior efficiency of the pump is credited to the absence of heavy reciprocating parts and the comparatively high speeds available.

For house service, as shown in the accompanying illustration, the pump is direct-connected to a suitable motor, and has its delivery line connected to a small air cylinder the piston of which, moving against an adjustable spring, controls a switch in the motor circuit. As long as water is being taken from the system this switch remains closed, but as soon as all the faucets are closed the pump quickly raises the pipe pressure to some predetermined value at which the switch is opened, stopping the motor. When a faucet is again opened the fall in line pressure at once starts the motor. The pipe system may be entirely drained, as in the case of closing up a house, by shutting off the supply of energy to the motor. Closing the main switch will start the pump, instantly delivering water to any faucet, without delay incident to filling water or compressed-air tanks. The von Pittler pump, being of the positive type, requires no priming and experiments have shown that these pumps will develop extremely high suction lifts, raising water in some instances 25 ft. or more. As the water delivered by this system is raised only to the height of the demand, a saving in energy consumed is made over the gravity-tank method. The efficiency of the pump is also high, approximating even 85 per cent, it is said, in the small sizes. As the water is taken fresh from the supply, warm water from unsanitary tanks is avoided in summer and freezing is prevented in winter.

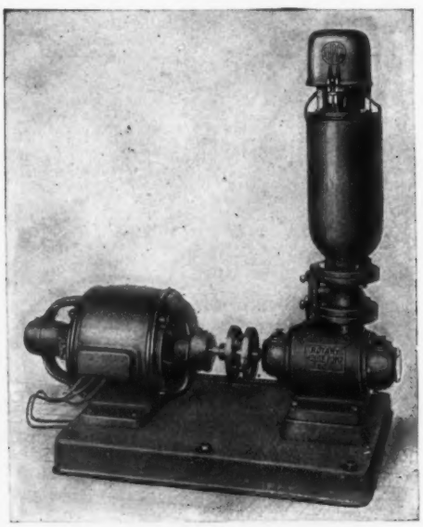


Fig. 1—Rotary Pump for House Service.

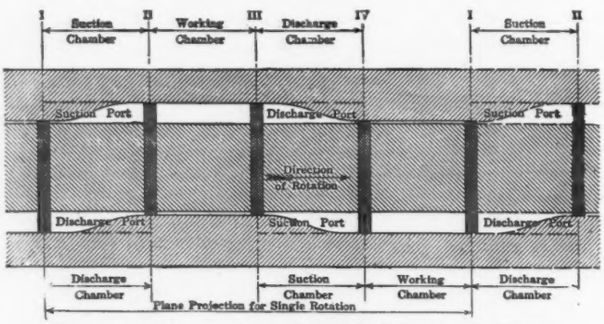


Fig. 2—Development of Cylindrical Parts of Pump.

The American rights for the von Pittler pump are owned by the Rotary House Pump Company, 103 Park Avenue, New York, which is introducing the apparatus into this country.

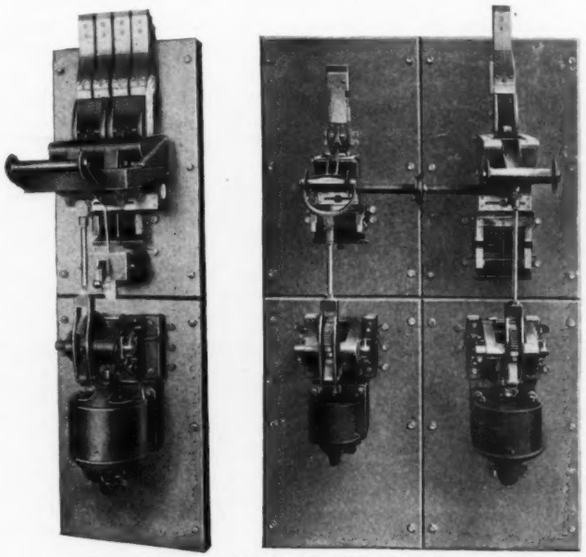
REMOTE-CONTROL CIRCUIT BREAKERS.

With the growth in the size of generating and motor units, which has been a prominent characteristic of recent developments in electrical engineering, there has arisen an imperative demand for reliable switching mechanism and protective apparatus which may be controlled from any required distant point. By the use of such appliances the engineer may secure economies of installation not otherwise available and at the same time improve the simplicity and increase the flexibility of the entire system. He is enabled also to locate his switchboard with due regard to space economy rather than with reference to immediate accessibility on the part of switchboard attendants, a consideration which is of the utmost importance where the room available is limited.

Remote-control circuit breakers and switches have the further advantage that they do not require to be massed together upon a single switchboard, but may be located in such a manner as will afford the most convenient and economical cable installation; for while the switching apparatus may be scattered around in various parts of the plant, as conditions dictate, the controlling devices therefor may readily be brought together at any point determined upon as the most convenient for the purpose. The switches and indicating devices for controlling a large number of circuit breakers may be placed upon a bench board of relatively insignificant dimensions, so that a large installation may by this means be placed virtually under the eye of, and within easy reach of, a single operator.

The Cutter Company, of Philadelphia, with a view to meeting the varied requirements of the modern plant has developed a complete line of this class of apparatus consisting of remote-control circuit breakers and switches operated by motor, solenoid or compressed air as best meets the conditions.

All of these forms have long since passed the tentative or exhibition stage and are in use or are being installed in some of the larger power plants in the country. To refer to only a few of these by name, probably the largest installation of Cutter apparatus is that of the United States Steel Corporation at Gary, Ind., where the use of the remote-control method resulted in such economies elsewhere as have long since paid for the remote-control equipment. The Interborough Rapid Transit Company, of New York City, has also an interesting equipment employing somewhat similar apparatus. It was found an economical method by the Murphy Power Company, of Detroit, and in the new power plant of John Wanamaker, Philadelphia, the first large department store in the world to avail itself of this system, it proved to be an economical means of overcoming certain difficulties in the installation.



Figs. 1 and 2—Motor-Operated Circuit Breakers.

Fig. 1 shows an 11,000-amp, single-pole, motor-operated circuit breaker. The remote-control circuit breaker is so constructed that it responds instantly if closed upon abnormal conditions against which it is designed to give protection; in other words, it embodies the effective non-closable-on-overload feature.

This class of apparatus lends itself admirably to service where the voltage of the control circuit is subject to variation, being equally efficient in operation on wide ranges of voltage. Much of this class of apparatus has been installed to meet what might be termed extraordinary conditions in fluctuation of voltage; in one case the normal e.m.f. being 250 volts, the apparatus had to operate satisfactorily anywhere between 30 volts and 300 volts, which condition the instruments have fulfilled, consuming a minimum amount of current in the operation, in fact, considerably less than is required for the operation of the solenoid type arranged for operation at a fixed voltage.

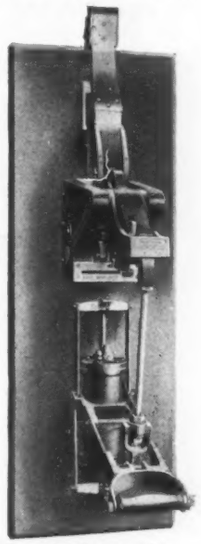


Fig. 3—Pneumatic Breaker.

The motor-operated circuit breakers close without the least shock or jar to the switchboard. Instantly upon the start of the closing movement the control switch is automatically short-circuited by the closing mechanism and the movement is completed without further action on the part of the operator.

Another use to which this class of apparatus lends itself is for the protection of storage boosters. Apparatus for this service is shown in Fig. 2, the smaller breaker being for the alternating-current motor side and the larger for the direct-current generator side. They possess all of the features above described and are so interconnected both electrically and mechanically that the generator breaker cannot be closed until the motor breaker is closed, while the opening of the latter causes the immediate opening of the generator instrument.

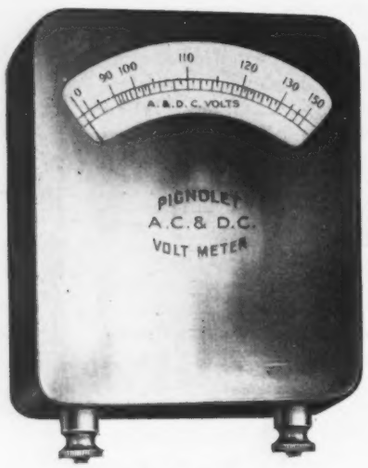
There are almost innumerable places where motor-operated circuit breakers may be advantageously used. Where three-wire generators are installed this class of protection is particularly advantageous, because in such cases by placing the circuit breaker outfit close to the generator the saving in the cost of cable installation not infrequently results in a saving in first cost as well as in the cost of maintenance.

That the merits of the remote-control method described above are being fully appreciated is shown by the standing of engineers adopting it. Pierce, Richardson & Neiler, of Chicago, have adopted it for the new terminal of the Chicago & Northwestern Railway now being erected, while the largest and latest similar equipment is that of the Curtis Publishing Company for its new plant now building in Philadelphia for the publication of the *Ladies' Home Journal* and the *Saturday Evening Post*. An exhaustive study of the subject on the part of Frank C. Roberts & Co., the engineers, resulted in its selection for this installation.

For installations which are already equipped with pneumatic machinery or signaling devices the Cutter Company has developed a pneumatic remote-control which has already been extensively used. Fig. 3 illustrates one of the simplest methods of controlling the circuit breaker from a distant point. The operating feature in this case consists primarily of a double-acting piston moving within a cylinder, each end of which has a valve-control connection with the compressed-air supply. The circuit breaker is opened by a movement of the control valve in one direction admitting air to the upper end of the cylinder; the closing of the circuit breaker is caused by an opposite movement of the control valve admitting air to the lower end of the cylinder.

POCKET INSTRUMENT FOR ALTERNATING AND DIRECT CURRENT.

The instrument illustrated herewith is of the electromagnetic iron-disk type, and its readings are said to be practically unaffected by variations in the wave-form or frequency of commercial alternating currents. It can be used also satisfactorily on direct current if not placed in strong magnetic fields, such as are found near masses of iron or any apparatus containing a magnet or strong current. The moving element consists of a specially shaped iron disk attached to the indicating needle. The disk is placed within the field produced by a magnetic coil. This coil is formed of fine wire provided with enamel insulation. The instrument is inexpensive to construct, but is said



Pocket Meter.

to give reliable indications after having been properly calibrated. The weight of the instruments is only 12 oz., and the size only 3.25 in. wide, 4.5 in. long and 1.125 in. deep, hence it can be carried in the pocket conveniently. Nevertheless over the useful range, the scale is open enough for fine readings

The voltmeter with single volt scale divisions between 100 volts and 120 volts is specially designed to give close readings on ordinary electric light circuits. The result is accomplished without increasing the size of the instrument by condensing the scales below 100 volts and above 120 volts where the readings are not of importance. The incandescent-lamp salesman, electrical contractor, inspector and others should find this instrument extremely useful and handy on account of its compactness.

The above-described instrument is made by L. M. Pignolet, 78 Cortlandt Street, New York.

SUBMARINE CABLES FOR THE PENNSYLVANIA RAILROAD.

The problem of satisfactorily caring for the numerous telephone, telegraph and signal wires necessary for the operation of a large and important railroad at points where its tracks cross a navigable river, making a drawbridge a necessity, has recently been solved by the Pennsylvania Railroad Company at its new Hackensack "draw" at the point where the Pennsylvania Terminal and Tunnel Division crosses the Hackensack River, a few miles west of Jersey City, by the use of submarine cables. There are two cables, one of thirty-five-pair No. 13 gage, triple-wrapped paper insulation, to be used for telegraph circuits, and the other of forty-five-pair No. 13 gage, double-wrapped paper insulation, having the wires of the inner core triple wrapped, and having eight pairs of this core twisted into double pairs, thus forming four phantom circuits. Each cable is 1225 ft. long, the thirty-five-pair cable weighing 11.5 tons and the forty-five-pair 12.5 tons. Each cable has a lead sheath 5/32 in. thick. Each sheath was saturated with a non-corrosive preservative compound over which were wound two layers of saturated jute put on in the reverse direction. Over this jute was placed an armor of No. 4 B. W. G. iron wire, the armor being saturated with a preservative compound, and over this were placed two thicknesses of hemp rope laid on in the reverse directions and thoroughly saturated with preservative compound. The average mutual electrostatic capacity of this cable is between 0.06 and 0.074 microfarad per mile.

These cables were made by the Western Electric Company at the Hawthorne (Ill.) factory. The work of laying the cables was done by the Postal-Telegraph Cable Company under the personal supervision of Mr. M. Keily, who represented Mr.

Terminal Box and Concrete Poles, and Cable Laid Under Hackensack River for Pennsylvania Railroad.

J. C. Johnson, superintendent of telegraph of the Pennsylvania Railroad.

One very interesting feature aside from the laying of the cable was the very efficient and durable line of concrete poles which terminated on either shore. These poles were cast by the railroad company in accordance with its own specifications, and it is expected that they will be found much more suitable in the low, swampy ground where they are placed than wooden poles.

The weight of the cable was such that it was not necessary to do any dredging along the river bottom, as it is expected that the weight of the cable will cause it to sink far enough into the mud to prevent injury.

The engineers of the Pennsylvania Railroad Company, who worked in conjunction with those of the Western Electric Company, were kept busy for some time designing and developing this cable, which is the very latest product for submarine work.

TELEPHONE TRAIN DISPATCHING FOR PERE MARQUETTE RAILROAD.

The Père Marquette is soon to join the already long list of railroads using the telephone to dispatch trains, supplanting the telegraph, which was considered the standard for handling train movements for a great many years. The Père Marquette has ordered instruments, selectors and line material to equip a line from Saginaw, Mich., to Toledo, Ohio, approximately 135 miles in length, with the telephone system for train dispatching.

This is said to be the beginning of the adoption of the telephone system over the entire road, as other extensions will follow the completion of the first circuits. Between Saginaw and Toledo there will be thirty telephone stations. The chief dispatcher will be located at Saginaw. The entire equipment is being furnished by the Western Electric Company.

POT-HEADS FOR UNDERGROUND CONSTRUCTION.

The application of the porcelain pot-head to underground cable work is being extended every year. This development has led to the manufacture of the devices herewith illustrated, which embody detachable features for special underground installations. Fig. 1 illustrates the application of the detachable pot-head to an underground installation for the emergency switching of the load of one circuit to another. This installation consists of twelve type "S" single-conductor pot-heads installed in the manhole. The four pot-heads to the left terminate the feeder cables of one circuit and those at the right come from another feeder. The caps are cross-connected to

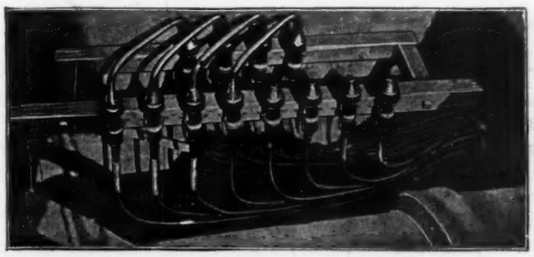


Fig. 1—Detachable Pot-Heads in Underground Work.

the four pot-heads in the rear which terminate the cables which carry the load.

The holes in the tops of the caps to the right are closed with compound. If it is necessary to shut the feeder down in an emergency or for construction changes, its entire load can be carried by simply shifting the caps on the four pot-heads at the left to the four at the right in the front row. This installation has operated satisfactorily even when the manhole is submerged in water.

There are many other situations in which any of two circuits can be arranged to be joined together through pot-heads and special switching arranged for. This is very essential in underground systems, as the repair of cables requires considerable time, and it is necessary to arrange to carry the load by way of other circuits during repairs.

For cases where multiple-conductor cables are employed the apparatus illustrated in Figs. 2 and 3 has been designed. This consists of a rectangular cast-iron box provided with a lid. The edges of the lid overlap the box. The box is provided with three wiping sleeves, two in one end and one in the other. The lid of the box carries the necessary number of detachable

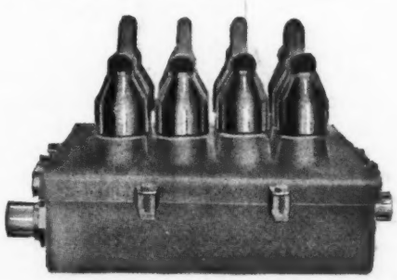


Fig. 2—Pot-Heads for Multiple-Conductor Cables.

devices. This device permits the multiple-conductor cable to enter the box through one of the outside sleeves and the distributing cables through the middle sleeve. The emergency tap or emergency circuit enters the box through the other outside sleeve. Each conductor is tapped inside the box to its respective disconnecting device and the box then filled with compound. Two rows of caps are then joined together by means of extra heavy rubber-covered wire well taped and compounded. The other row of caps are closed at the top.

It can readily be seen that by the use of this box the entire load on the feeder can be switched to the emergency tap by merely throwing the caps to the other row. The cast-iron lid of the box contains a rubber gasket, and since the tubes and box are filled with compound, it is impossible for water to enter; the overlapping edges of the box and caps, retaining the air, will not allow the water to enter into the working parts. The application of these boxes can be extended to installations requiring a desired number of switching devices.

One advantage of these devices, which are manufactured by the G. & W. Electric Specialty Company, 6408 Jackson Park Avenue, Chicago, Ill., is the ready accessibility of the switching devices, which permits the switching to be done quickly, without requiring the removal of bolts which may have become rusty, and obviating entirely any interference with the interior

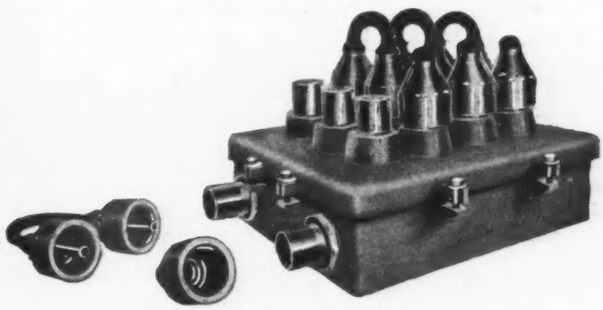


Fig. 3—Three Pot-Head Caps Connected.

of the box after it is once installed. All switching is done by merely transferring the caps. Fig. 3 shows the box with three caps connected and one blank cap removed from the box.

ASBESTOS-INSULATED RECTANGULAR WIRES.

For several years the D. & W. Fuse Company, of Providence, R. I., has been manufacturing an asbestos-insulated wire known under the trade name of "Deltabeston." Its insulating and heat-resisting properties have brought it into extensive use for railway and hoisting motor, field, armature and controller coils, arc lamp magnets, heating units and for many other devices subjected to severe overloads or high temperatures. "Deltabeston" wire, it is claimed, requires a temperature of 1000 deg. Fahr. to start the disintegration of its asbestos covering, and a temperature of 1800 deg. to decompose the asbestos completely. Thus a coil can be run at a dull red heat without causing a breakdown in its insulation. These qualities created a demand for Deltabeston wire of rectangular section as well as round. At first it seemed an easy matter to treat a square or a flat wire in a manner similar to round "Deltabeston," but the company states it was only after a large amount of time and money had been expended in painstaking experimenting that the present method was perfected. The advantages of square or flat wires for certain purposes are numerous. For instance, it is a well-known fact that about 10 per cent greater copper section can be put into a given winding space by the use of rectangular wires than by employing round conductors. This is due to the perfect bedding secured by using wires with flat sides, between which practically no space is wasted. The reduction of lost space in a winding is advantageous in two other ways; first, less compound is needed to fill a coil if it is to be impregnated; and, second, the heat radiation is greatly improved by avoiding large spaces filled with a comparatively poor conductor of heat. An advantage of almost equal importance is that certain features of winding operations are facilitated by the use of flat-sided wires, especially when large conductors must be handled. Thus there is a great tendency for round wires to cut into any flat insulation between layers, due both to the tension in winding and chaffing in service. With flat wires the pressure of the conductors on the between-layer insulation is distributed over large surfaces instead of being applied in lines at the centers of every wire. Therefore, greater stress can be applied in winding a flat wire with less chance of injuring the insulation underneath it.

EXHIBITS AT CONVENTION OF ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.

There was a good showing of appropriate electrical exhibits at the recent annual convention of the Association of Railway Electrical Engineers in the Hotel La Salle, Chicago. The entire nineteenth floor was given over to the collection of exhibits and to the meeting place of the association. Following are brief notes relating to exhibits and exhibitors:

Adams & Westlake Company, maker of railway supplies, was represented by R. M. Newbold.

Automatic Annunciator Company attracted much attention by a loud-talking telephone device for announcing trains and stations. J. J. Comer, P. P. Hinckley and Lewis Cole were in charge.

Baird Electric Company exhibited a railway telephone signal system for steam and electric roads. A. E. Case and E. P. Baird represented the company.

Benjamin Electric Manufacturing Company exhibited a new line of reflector sockets ranging from 25-watt small standard bases up to 500-watt large bases. It also showed tungsten series fixtures. H. E. Watson and Geo. C. Knott represented the company.

Central Electric Company displayed Columbia incandescent lamps, Okonite wire, D. & W. fuses, Diehl fans, Opalux shades, junction boxes, train-line connectors, etc. The exhibit was in charge of J. M. Lorenz, G. M. Cox and D. Woodhead.

Columbia Incandescent Lamp Company exhibited a full line of its lamps, including 500-watt, 400-watt, 250-watt, 200-watt, 150-watt, 100-watt, 60-watt, 40-watt and 25-watt Mazdas for 110-volt circuits and also 25-watt and 15-watt train-lighting Mazdas for 32 volts and 60 volts. Train-lighting tantalums, including 80-watt, 32-volt and 60-volt lamps, also a 500-watt Mazda especially designed for factory and shop lighting, were shown. The exhibit was in charge of C. B. Oldham and J. G. Boyd.

Commercial Acetylene Company demonstrated its acetylene car-lighting system. The exhibit was in charge of Mr. H. G. Doran.

Consolidated Railway Electric Lighting & Equipment Company showed its axle-light system for train lighting.

Crouse-Hinds Company exhibited receptacles, knife switches, rosettes, sockets, harpoon guy anchors and the Imperial luminous headlight for electric and steam cars.

R. & J. Dick, Ltd., of Glasgow, Scotland, and Passaic, N. J., exhibited Dickbelt for train-lighting purposes. E. H. Griffith, H. W. Spalding and J. E. Macfarland were in attendance at the exhibit.

Edison Storage Battery Company showed the Edison nickel-iron battery for train lighting work. The display was in charge of H. G. Thompson.

Electric Storage Battery Company displayed storage batteries for signal and car lighting, as well as for vehicle use. The company was represented by G. H. Atkin, H. E. Hunt, T. A. Cressey, R. I. Baird, J. N. Rosholt and P. G. Downton. Included in the exhibit was a group of Manchester positives which had been in use for car-lighting service on the Chicago, Milwaukee & St. Paul Railroad for twelve years.

General Electric Company displayed modern Mazda lamps for train lighting and distributed copies of its various publications. The representatives of the company present were J. Scribner, E. M. Hawley, Henry Schroeder and W. S. Taussig.

Gould Storage Battery Company showed the Gould Simplex System in Exhibit Hall, and also a special operating exhibit on the floor below. The operating exhibit included the new Simplex regulator and mechanical polechanger. The interests of the company were in the hands of Rufus N. Chamberlain, G. G. Milne, W. F. Bouche, J. W. Jepson, Geo. R. Berger, W. M. Lalor and Chas. F. Krech.

Holophane Company was represented by C. A. Howe and showed a new line of train-lighting reflectors, including a steel type for mail cars and a new prismatic glass reflector.

Jandus Electric Company exhibited railway ventilating apparatus, comprising circulating and exhaust fans. B. A. Stowe, W. L. Cummiskey and C. W. Beach were in charge.

Kerite Insulated Wire & Cable Company made a display of its insulating wires and cables, in connection with the Watson Insulated Wire Company.

Luitweiler Pumping Engine Company showed models of non-pulsating pumps for railroad work. E. D. Williams was in charge.

W. N. Matthews & Brother were represented by V. L. Crawford.

Moloney Electric Company was represented by T. O. Moloney.

Monarch Incandescent Lamp Company, through Fairbanks, Morse & Company, was represented by J. S. Corby and J. S. Banks.

National Electric Lamp Association exhibited a full line of carbon, tantalum and Mazda lamps, including low-voltage lamps for train-lighting systems. The latter take 15 watts to 50 watts on 30-volt and 60-volt circuits. There were also large Mazdas, plain and frosted, up to 500 watts. C. W. Bender, J. T. Henninge and H. J. Raymond represented the association.

New York Leather Belting Company had a special belting for car-lighting systems.

Nungesser Electric Battery Company showed Acme Rapid dry batteries and "1900" dry batteries as well as carbon brushes.

Oneida Steel Pulley Company showed steel flange pulleys for railway car-lighting service and also a new split taper steel bushing. The exhibit was in charge of N. G. Stark and H. P. Gale.

Pyle National Electric Headlight Company displayed the Pyle headlight system. The exhibit was in charge of M. A. Ross.

Safety Car Heating & Lighting Company exhibited its axle-light train-lighting system and fixtures. Those representing the company were G. E. Hulse, H. H. Halm, J. G. Van Winkle, W. G. Hermsen, C. A. Pinyerd, C. A. Luckey and A. C. Moore, their Chicago manager.

Tipless Lamp Company showed its tipless tungsten lamps for railroad work. Among these is type G 18½ for 30 volts in units of 12 cp, 16 cp and 20 cp, for which an efficiency of 1 watt per candle is claimed. The exhibit also included the Heany tungsten lamp and the Heany fireproof wire. R. S. Carrick and R. P. Lee represent the company.

United States Light & Heating Company showed its axle-lighting system, including generators and controlling devices, as well as the National storage battery. The new automatic controller for variable output in axle lighting was a feature. The exhibit was in charge of C. E. Mead, C. A. Hooper, L. S. Cunny, J. E. Sinclair and W. Hungerford.

Western Electric Company displayed Hawthorn flaming-arc lamps, interphones for railway shops and offices, Hawthorn Mazdalier fixtures and Mazda lamps. George H. Porter George H. Lounsbery and R. N. Engers were in attendance. The lamp part of this exhibit showed the standard Mazdas in sizes from 16 watts to 500 watts, also train-lighting Mazdas, tantalums and Gems for 60 volts and 32 volts.

Westinghouse Electric & Manufactuing Company exhibited tungsten lamps for from 15 watts to 500 watts and also special metallic-filament car-lighting lamps of 6 cp and 8 cp. The principal feature of the exhibit was the new "wire-type" tungsten lamp, showing the several parts of the lamp. T. G. Whaling, B. F. Fisher, Jr., J. M. Schilling, A. N. Brown, L. N. Pyle, R. F. Moon and R. E. Schaulin were the representatives of the company.

Willard Storage Battery Company displayed the Willard standard train-lighting battery. T. A. Willard, R. Norberg, W. E. Ballantine and L. Sears explained the exhibit to interested visitors.

M. M. Wood gave a demonstration of the gyroscope on Thursday afternoon in the exhibit hall, and the exhibition was greatly appreciated.

Industrial and Commercial News

The Week in Trade.

REPORTS from trade centers last week were very little better than those for the previous week. There seems to be a slightly increased demand from jobbers and retailers, due to the advance of the season, but this increase is not sufficient to make manufacturers at all overjoyed. Distribution to consumers in some sections of the West has been improved by fall festivals and state fairs. Crop reports are all that could be desired, and the fact that no serious frosts have been reported in any portion of the corn belt assures the maturing and harvesting of this crop without any serious damage. Leading trade authorities contend that the disturbed political situation is acting as a deterrent upon business. Whether this is true or not it is certainly a fact that all lines of business are experiencing a period of quiet, if not of depression. In the industrial world there are few changes, and the majority of mills and factories are running far below capacity. High prices for raw material, particularly in the cotton and woolen industry, are making manufacturers conservative, and are rendering it difficult for them to figure clearly on the future. The iron and steel industries are quieter than at any period during the current year. The United States Steel Corporation reports that new orders are not now being taken in excess of 10,000 tons a day, which is only about 25 per cent of the capacity of the mills. It is said that the total tonnage taken in September will not exceed 300,000 tons. Commodity prices continue to sag, but as yet they have not declined sufficiently to furnish much encouragement to the export trade. Collections, especially throughout the West, are very much better, and there seems to be no tension among the Western bankers. Business failures for the week which ended Sept. 29, as reported by *Bradstreet's*, were 211 as against 190 the previous week, 195 in 1909, 225 in 1908, 177 in 1907 and 136 in 1906.

The Copper Market.

COPPER prices were a trifle stronger last week, and in the last few days of the week there was a little more activity and some evidence of speculative buying in standard warrants. The renewal of activity caused selling agencies and holders to refuse concessions, and in many instances even to advance the figures. The actual demand for consumption, both in this country and in Europe, showed very little improvement. It is generally predicted that the September statistics will show domestic takings to be considerably smaller. It is also believed that the figures of production will be somewhat reduced. Quite a number of optimistic views are expressed in the market, and there is evidently more confidence in copper stocks in Wall Street, as is shown by the net gain of 3⅛ points for Amalgamated during the week. One of the best posted copper men connected with the selling end of the trade is quoted as saying: "As far as our business is concerned there is no falling off in demand, and I am giving the matter no serious thought, for I believe that Europe will be more than able to take care of any falling off in consumption in this country arising from curtailment in business. When Europe purchased large stocks of metal in July and August, it was because the foreign consumers had been fighting the market and had allowed their stocks to run down to a starvation basis. The American copper they bought at that time was not more than sufficient to fill up the gaps which their hand-to-mouth policy had allowed to occur. The consumption in all of the principal foreign countries, especially Germany, is at the present time very encouraging." The exports for the month of September were 31,733 tons. Much of this, it is claimed, went into European warehouses. Standard copper was quoted on the Metal Exchange Oct. 3 as per the accompanying table.

Standard Copper:

	Bid.	Asked.	Settling price.
Spot	12.05	12.17½	.....
October	12.05	12.17½	12.12½
November	12.12½	12.17½	12.15
December	12.12½	12.20	12.15

The London market, Oct. 3, was as follows:

	Noon. £ s d	Close. £ s d
Standard copper, spot	55 10 0	55 8 9
Standard copper, futures	56 6 3	56 5 0

Extreme fluctuations for this year:

	Highest.	Lowest.
Standard	13.50c	11.70c
London, spot	£62 0 0	£52 15 0
London, futures	65 18 0	53 7 6
London, best selected	65 10 0	57 15 0

Industrial and Commercial Notes.

Good Demand for Mica.—One of the principal importers of mica is responsible for the statement that the demand for mica has been very good throughout the current year, and that prices have been satisfactory. The consumption of mica is fairly steady, according to this authority, especially the demand from the electrical industry. It is claimed that the new tariff upon mica, which apparently reduced the rate of duty from 6 cents to 5 cents on untrimmed and from 12 cents to 10 cents on cut mica, has in reality resulted in importers paying a higher tax. This has been brought about by the difference in classification. Thumb-trimmed mica, which was formerly admitted as uncut and at the lower rate of duty, has been held by the treasury officials to be cut mica and dutiable at the 10-cent rate. Some months ago Eugene Munsell & Company secured a decision from the United States Board of General Appraisers declaring that mica of this character should come in at the lower rate. From this decision the United States government has appealed to the new Customs Court of Appeals, and this case will probably be heard during the current month. As the bulk of the mica that is used in this country is what is known to the trade as untrimmed, the final decision in this case is extremely important, and is awaited with great interest by importers.

Rubber Prices Lower.—The London market for crude rubber was considerably demoralized during the past week. It is even claimed that some of the large houses are in need of financial assistance to prevent failures. It is likely that assistance will be forthcoming in order that an open crisis may be averted. The London financial authorities charge the trouble in crude rubber to American manipulation. This may or may not be true, as London is in the habit of charging many of its troubles to "American manipulation." The market for shares in the many rubber development companies which were promoted last spring is practically dead. Very few transactions are now recorded. Crude rubber in the local market has been declining, and Para is now quoted at $1.45 a pound. This is encouraging manufacturers to buy a trifle more liberally. A steady market between $1.25 and $1.50 would be very satisfactory to manufacturers at the present time, and would do much to encourage the rubber trade.

Hall Signal Company.—The Hall Signal Company reports that its business is unusually good for this time of the year, and that the record of 1910 will probably be the largest in the history of the company. The books of the company are well filled with orders, although no very large contracts for signal apparatus have been placed recently by the railroads. The plants are being operated with a full day force, although the night shift which was employed up to a few weeks ago has been cut off. Dividends on the stock are not likely to be resumed, as the management intends to increase its working capital before making any disbursements.

Westinghouse Electric & Manufacturing Company.—The Westinghouse Electric & Manufacturing Company has recently received an order from the Simonds Manufacturing Company for six 500-kva transformers and two 200-hp rolling-mill motors to be used in the new Lockport (N. Y.) plant of the purchaser. One of the motors will be used on the hand saw-mill and the other on a cross-cut saw-mill. The motors will be geared to the mills, which will consist of two stands each. The motors will be so constructed as to permit the moving of the stator sideways in case of necessary repairs to the motor.

Long Island Railroad Cars.—The Long Island Railroad Company has received 65 of its new all-steel motor cars out of the order for 140 placed last year with the Pressed Steel Car Company. It is promised that 25 more cars will be delivered during October. These cars are for use on the main line between Jamaica and the new Pennsylvania Railroad station. They cost $18,500 each, and are asserted to be entirely fireproof and practically indestructible in case of collision.

New Westinghouse Plant.—Contracts will soon be awarded by the Westinghouse Electric & Manufacturing Company for the construction of the large foundry plant at Trafford City, Pa., mention of which was made in our issue of Aug. 4. The plant will be erected on the seventy acres of land recently bought by the company, and will be adjacent to the foundry of the Westinghouse Machine Company. The plans call for the investment of about $3,000,000 in buildings, and when completed 3000 men will be employed. Two foundries will be built, one for small castings, which will be a structure 200 ft. wide and 600 ft. long, with crane runways for handling the raw material and finished product; the other, which will be for large castings, will be 300 ft. wide and 800 ft. long and will be equipped with larger cranes. There will also be a pattern shop and pattern storage building, which will be 200 ft. wide, 600 ft. long and six stories high. The buildings will be constructed of fireproof material, with concrete floors. There will be added large shipping and receiving yards for railroad service. The entire trackage system in the plant will be constructed by the Inter-Works Railroad Company, which is controlled by the Westinghouse Company. A new power plant will also probably be built for operating these foundries. With the end of September the Westinghouse company concluded the first six months of its fiscal year, and reports that its average net earnings were about $500,000 per month. If this rate is kept up it will mean net earnings of $6,000,000 for the year, which is equivalent to 15 per cent on the company's capitalization.

Northern Colorado Power Company.—At the office of Henry L. Doherty & Company in New York an emphatic denial was given to the story, published in Denver, that plans had been formulated to take the Northern Colorado Power Company into the newly formed Cities Service Company. The new holding company has so far taken over no other property than those originally mentioned—the Denver Gas & Electric Company, the Empire District Electric Company and the Spokane Gas & Fuel Company. Other companies may be included later, but the intimation is made that the Northern Colorado Power Company is not one of those under consideration. The company was formed about three years ago and has several hydroelectric plants and extensive transmission lines in Northern Colorado and Southern Wyoming. The company furnishes energy to many towns and mines in the neighborhood of Boulder and has recently made arrangements to enter quite largely into the irrigation developments. It is capitalized at $3,000,000 but has never paid a dividend.

Electrical Construction.—Among the items printed under Construction News in our present issue are announcements of proposed new plants or considerable extensions to present plants at Salt Lake City, Utah; Williamsburg, Va.; Sharpsburg, Md.; Lakeview, Ore.; Fergus Falls, Minn.; Haverhill, Mass.; Marion, Ind.; St. Louis, Mo.; Asheville, N. C.; Harrisburg, Pa.; Farmington, N. M.; Athens, Ohio; Lancaster, Ohio; Avondale, Pa.; Philadelphia, Pa.; Richland, Ga.; Bayonne, N. J., and Walhalla, S. C.

Electrifying London Tramways.—It is announced in London that the County Council has decided to apply for parliamentary powers for the construction of 22½ miles of electric tramways, to replace the horse and motor omnibuses. There has been rapid progress in the construction of electric lines in the city of London within the last few years. In 1906 there were only 58½ miles of electric lines under the control of the London County Council, and at this time there are 113½ miles.

Edison Electric Illuminating Company of Boston.—At a recent meeting of the directors of the Edison Electric Illuminating Company of Boston, Robert Saltonstall was elected a member of the board to fill the vacancy caused by the death of George Dexter. Thomas K. Cummins, treasurer of the company and for some time a director, was elected a member of the executive committee to fill the vacancy caused by Mr. Dexter's death.

New Pennsylvania Power Companies.—Charters were issued last week at Harrisburg, Pa., for five new power companies in Northeastern Pennsylvania. These companies are to be located at Pen Argyl, Stockertown, East Bangor, Wind Gap and Tatamy. Each will bear the name of its town and is given an initial capitalization of $5,000. C. H. Briscoe, of New York, is named as the chief incorporator.

New Plant in Joliet.—Ground was broken last week at the Joliet steel plant of the Illinois Steel Company for an electric generating plant which will cost in the neighborhood of $1,000,000. The waste gas from the coke ovens will be utilized for fuel, and three 3000-kw generators will be installed. The appropriation for this improvement was recently allowed by the United States Steel Corporation.

Niagara, Welland & Lake Erie Railroad Company.—The Niagara, Welland & Lake Erie Railroad Company has applied to the Canadian Parliament for permission to construct an electric railway line from Niagara Falls, N. Y., to points on Lake Erie between Fort Erie and Fort Dover, via Welland and Port Colborne.

Financial.

The Week in Wall Street.

WALL STREET enjoyed a more active period last week than in any of those which immediately preceded it. The total sales of stock amounted to 2,204,473 shares, which would not be considered large in the palmy days of the financial district, but which is double the record for some of the recent weeks. Prices also were considerably improved, and almost every active issue showed a net gain for the week of from two to five points. This improvement is surprising to some of the financial experts, in view of the complicated political situation and the free predictions that there will be a change of the political supremacy in several states. Wall Street no longer views with anxiety political changes. There have been so many political complications in recent years which were threatening to corporate interests, in which the party of opposition had no hand, that financiers have come to believe that one set of politicians is likely to be as bad as the other. The sentiment of Wall Street is very much improved, and it seems that the only thing lacking for the development of a material upward movement is the leadership of some strong and aggressive individual. A number of financiers who returned from Europe within the past fortnight have reported that both England and the Continent are anxious to buy our securities as soon as settled conditions in politics and business prevail in this country. It is believed that the time is not far distant when it will be able to place legitimate bond issues in Europe. Last week's developments in the international money market seemed to indicate that the end of the protracted period of cheap money in this country is at hand. The Bank of Germany has established an official rate of 5 per cent, and the Bank of England has fixed its discount rate at 4 per cent. American bankers must follow suit, and we may look for much stiffer rates on time loans. During the past two weeks the Southern borrowings have been heavy, and the drain upon the resources of Wall Street banks was shown in the loss of cash reported in the last statement. Rates for money Oct. 3 were: Call, 2@3 per cent; 90 days, 4½ per cent. The quotations in the table are those at the close on Oct. 3.

NEW YORK.

	Sept. 26.	Oct. 3.	Shares sold.		Sept. 26.	Oct. 3.	Shares sold.
All.-Ch.	8¼*	8¼*	300	Int.-Met., pfd.	56¾	56⅜	27,150
All. Ch., pfd.	30*	30*	———	Mackay Cos.	92½*	92	300
Amal. Cop.	62	65⅛	101,060	Mackay C.,pf.	73⅝*	75½	364
Am. D. T.	20½*	20½*	———	Man. Elev.	138*	143½	4,630
Am. Loc.	37⅝	39	2,700	Met. St. Ry.	15*	15*	———
Am. Loc.,pfd.	104½*	102½*	110	N.Y.&N.J.Tel.	139¼*	139¼*	———
Am. Tel. & C.	71*	75*	1,277	Steel, com.	68⅜	70⅛	316,590
Am. T. & T.	137⅝	137⅞	11,930	Steel, pfd.	116¼	117⅝	2,920
B. R. T.	76⅜	76⅞	25,880	W. U. T.	68½	74½	18,845
Gen. Elec.	145	146	1,200	West'h, com.	62½	66½	3,400
Int.-Met.	21½	21	27,100	West'h, pfd.	125*	128¾	400

PHILADELPHIA.

	Sept. 26.	Oct. 3.		Sept. 26.	Oct. 3.
Am. Rys.	43¼*	43¼*	Phila. Elec.	15⅞	15⅞
Elec. Co. of A.	11½*	11½	Phila. R. T.	18¼	19⅛
Elec. St. B'ty	47	48¾	Phila. Trac.	81*	83
E. S. B'ty, pfd.	30*	30*	Union Trac.	43½	44

CHICAGO.

	Sept. 26.	Oct. 3.		Sept. 26.	Oct. 3.
Chi. City Ry.	180*	180*	Chi. Tel. Co.	120*	120
Chi. Rs., Ser. 1.	61½	64½	Met. El. Co.	19*	19*
Chi. Rs., Ser. 2.	15⅞	15½*	Met. El., pfd.	60*	60*
Com. Edison	112*	112*	Nat'l Carbon.	123*	126
Chi. Subways	4½	4	Nat'l Car., pfd.	119½*	119½

BOSTON.

	Sept. 26.	Oct. 3.		Sept. 26.	Oct. 3.
Am. T. & T.	138⅜	138	Mex. Tel.	5¾*	5⅜*
Cum. Tel.	143	143*	Mex. Tel., pfd.	6½*	6½*
Edison E., Ill.	257½*	258	N. E. Tel.	130	130*
Gen. Elec.	145	145¼*			
Mass. E. Ry.	18	20¼	W. T. & T., pfd.	83*	90*
Mass. E. Ry., pfd.	81½	84¾			

*Last price quoted.
Shares sold for week Sept. 26 to Oct. 1.

FINANCIAL NOTES.

Philadelphia Rapid Transit.—The annual report of the Philadelphia Rapid Transit Company for the year which ended June 30, 1910, shows gross receipts of $17,991,100, as compared with $18,317,529 the previous year. The total net income, after paying taxes and other expenses, amounted to $7,044,741, as compared with $7,968,303 the previous year. Deducting from this the fixed charges, the company shows a deficit for the year of $1,329,723, as compared with $224,270 the previous year. The report of the president says that had it not been for the strike of the motormen and conductors, which lasted more than two months last spring, a very different statement would have been submitted. "At the time the strike was called," says the president's report, "the company had in the seven months of the fiscal year shown an increase of $681,964 in gross receipts, and $285,819 in net receipts. Had the same rate of increase continued for the fiscal year the company would have shown an increase in gross earnings of $1,261,469. The actual loss in passenger receipts during the sixty-six days of the strike, compared with the receipts of the year before, was $1,558,104. This is considering only the loss of receipts while the strike was in progress; it takes weeks and even months after a prolonged strike to get traffic back to its former condition, and it is doubtful whether even at the end of the fiscal year the receipts of the company had become normal. In addition there was a very heavy increase in the expense of the operation of the road, and it is estimated that extraordinary expenditures amounted to $836,855." The directors have charged off the entire strike expense, and provided for it by additional financing.

Earnings of Hydroelectric Development on Chicago Drainage Canal.—D. M. Deininger, comptroller of the Sanitary District of Chicago, has presented a report to the president and board of trustees for the first six months of the year 1910, showing the income and operating expenses of the electrical department of the district. The total income for the half year was $258,326, compared with $166,035 for the corresponding period of 1909, an increase of $92,291, or 55.5 per cent. The operating expenses, including depreciation, are placed at $113,795, an increase of 29.1 per cent over the corresponding period of the year before. The net earnings were $144,531, an increase of 85.5 per cent. The interest on cost of plant and the rentals are placed at $82,723, leaving $61,748 as profit. The operating expenses for the electrical department of the Sanitary District for the first half of 1910 are divided as follows: Production expenses, $15,623; transmission expenses, $21,194; distribution expenses, $8,184; utilization expenses, $6,260; commercial expenses, $5,677; salaries and general expenses, $21,169; depreciation, $35,686; total, $113,795. The total cost of hydroelectric plant and equipment as of June 30, 1910, is given as $4,267,614. The ratio of depreciation to cost of plant and equipment (per annum) is 1.67 per cent. Including depreciation, the net earnings are figured in Mr. Deininger's statement, for the first half of the year, at the rate of 6.77 per cent per annum. The greater part of the electrical output of the Sanitary District is sold to municipal bodies at low rates.

Montreal Power-Street Railway Merger.—During the past week a circular was issued by the board of directors of the Montreal Street Railway Company, through Secretary Patrick Dubee, to the shareholders, confirming the anticipated reports that it was proposed to unite the Street Railway Company and the Montreal Light, Heat & Power Company on the basis of the forecast figures of 250 per share for Montreal Street and 190 for the Power stock. It was proposed to form a holding company which would exchange its shares for those of the two companies on this basis. A statement of net income was made showing the combined net income to have been $2,687,824 in 1907, $2,882,258 in 1908 and $3,140,877 in 1909. Assuming that all the shares of the two companies were transferred upon the above basis, it would mean a holding company of $57,300,000, and the percentage of income upon this capital would be 4.69 in 1907, 5.03 in 1908 and 5.48 in 1909. The shareholders were asked for an expression of opinion on the proposed merger at the next general meeting. A great deal of opposition to the proposed amalgamation of the two concerns has been aroused by one of the papers, and it was rumored during the week that on account of the publicity given there was a likelihood of the consolidation not being carried through. Nothing authoritative on this point could be learned, and it is not probable that anything further will be done until the annual meeting of the Montreal Street Railway shareholders in November.

Telegraph Rumors in Wall Street.—A report was current in Wall Street last week that a deal had been effected between the Western Union Telegraph Company and the American Telephone & Telegraph Company, by which the latter company would take entire control of the former. The result of this report was a sharp advance in Western Union stock and some increase in the telephone stock. It was reported that plans had been developed by which the American Telephone Company would exchange five shares of its stock for seven shares of the Western Union stock. The rumors were emphatically denied by Theodore N. Vail, president of the American Telephone Company, who said: "There is absolutely not a shred of truth in these reports. The American company has not had and does not now have plans for the acquisition of any additional shares of the Western Union. We are satisfied to remain minority stockholders."

Federal Telephone & Telegraph Company.—The Federal Telephone & Telegraph Company, of Buffalo, which was formed in January, 1909, to take over a number of independent lines in the northern portion of New York State, has, according to the report of its president, B. G. Hubbell, been extremely successful and rapidly increased its earning capacity. During the six months ended June 30 last its revenues rose more than 50 per cent over the same period of 1909, and approximately 30 per cent over the six months which ended Dec. 31, 1909. The net profits of the company, after paying all fixed charges, for the six months which ended June 30 last were $120,978. The report of the president says that the City of Buffalo alone is using the company's service more than 6,000,000 times per year, which covers more than a majority of the telephone use in that city.

National Carbon Company.—The directors of the National Carbon Company last week declared the usual quarterly dividend of 1½ per cent on the common stock. The dividend is payable Oct. 15. There had been many rumors that the rate would be increased. Failure to do so, however, has not weakened the position of the stock. A year ago the company raised the rate of the common shares from 4 per cent to 5 per cent, and later on to 6 per cent. The company is said to be doing an immense business, and the price of the common shares, which are several points above the 7 per cent cumulative preferred, suggests that there is some plan ahead which will be more valuable to the stockholders than a mere advance in the dividend rate.

Connecticut Company Plans.—Plans for making the Connecticut Company stand in a new relation to the New York, New Haven & Hartford Railroad Company, which owns all of its stock, provide for a new capitalization to be based on the bonded debt and advances for improvements. The bonded debt of the Connecticut Company amounts to about $27,000,000, and advances for improvements to about $9,000,000. Under the new plan the parent company will take up all of the Connecticut Company's obligations, paying them as they mature, thus ultimately leaving the trolley company free from debt. The Connecticut Company owns or controls about 80 per cent of the trolleys in Connecticut, and its gross receipts last year amounted to nearly $8,000,000.

Northern Illinois Electric Railway Company.—A copy of the trust deed of the newly organized Northern Illinois Electric Railway Company has been filed by the Chicago Title & Trust Company in every county in Illinois through which the proposed line will pass. The first bond issue which is covered by this mortgage will amount to $2,000,000. It is proposed to construct a railway from Elgin to Peoria, and the line will pass through the counties of Kane, Kendall, DeKalb, Lee, Bureau, Stark and Peoria. E. P. King, of Lee Center, is president of the new Company.

Columbus (Ohio) Railway & Light Company.—The directors of the Columbus Railway & Light Company have failed to declare the regular quarterly dividend of ¾ of 1 per cent which would ordinarily have been paid Oct. 1. The reason for this omission is the strike which began July 24 and has not yet been settled. During the entire strike period the company has been in partial operation only and the extraordinary expenses have been very heavy.

Increase of St. Louis Company Capital.—In order to carry out its plans for extensions and improvements, the Suburban Electric Light & Power Company, of St. Louis, has increased its capital stock from $209,000 to $750,000.

Detroit United to Resume Dividends.—It is stated in Detroit that the United Railways Company of that city is planning to resume dividends on its outstanding capital stock. In order to do this, however, it will be necessary for the company to sell the bonds now held in the treasury. During the last three years over $4,000,000 has been expended for improvements and extensions out of the earnings. In addition to this, the floating debt, which in 1907 amounted to $1,500,000, has been taken up. J. C. Hutchins, president of the company, says that it is to be hoped that before the expiration of the present year the differences between the city and the company will be satisfactorily adjusted, enabling the bonds to be sold, and relieving the underwriters of their obligations, on which they will then receive a bonus of 2 per cent.

Chattanooga Railway & Light Company.—For the first seven months of the present year the gross returns of the Chattanooga Railway & Light Company showed an increase of $57,600, or 13.12 per cent over the previous year. The net for the same period showed a gain of more than $59,200, or 32.8 per cent over the corresponding period of last year. This company was recently chartered under the laws of the State of Tennessee as a successor to the Chattanooga Electric Company and the Chattanooga Railways Company, and has acquired all the property, rights, franchises and equipment of these companies. The company possesses liberal franchises, and the territory which it serves is rapidly increasing in population and business.

Public Service Corporation of New Jersey.—The Public Service Corporation of New Jersey has sold $4,000,000 of 5 per cent, three-year collateral gold notes to J. P. Morgan & Company, of New York, and Drexel & Company, of Philadelphia. These notes are secured by a deposit of $5,000,000 general collateral mortgage bonds of the company. These bonds are a portion of the $50,000,000 issue which was recently authorized, and of which $13,500,000 have been already sold. It was intended to dispose of other portions of this issue as the needs of the corporation required, but it has been decided that at the present time the bond market is not in a condition to make the sale of these securities advisable. This is the reason for the issue of the short-time notes.

Independent Telephone Company, Seattle.—The controlling stockholders of the Independent Telephone Company, of Seattle, Wash., who are citizens of Youngstown, Ohio, have sold their interests to a New York syndicate for $2,000,000. The purchase price has been deposited in a Youngstown financial institution, and will be distributed among the stockholders at once. It is reported that the syndicate buying this stock represents the Bell telephone interests, but this report has not been confirmed. The reason given by the Youngstown people for disposing of these securities is that they live too far away from Seattle to handle the property with convenience.

American Light & Traction Company.—The directors of the American Light & Traction Company have declared the regular quarterly dividends of 1½ per cent on the preferred stock and 2½ per cent cash and 2½ per cent stock on the common. In the first eight months of the current year the company earned a surplus, after preferred dividends, of $1,668,747, equivalent to about 16.5 per cent on the outstanding common stock. The earnings at the present time are running on the same high basis and it is believed that the annual report will show about 28 per cent on the common.

Chicago & Milwaukee Electric Company.—The report of the receivers of the Chicago & Milwaukee Electric Company for the first five months of the current year has been filed with the United States Circuit Court, and shows a deficit of $12,693 after meeting all operating expenses, taxes and interest on the receivers' certificates. The balance sheet of the company as of May 31 shows total assets of $498,934, including $68,639 spent for additions and betterments under the receivership, also $46,238 spent for equipment.

DIVIDENDS.

American Power & Light Company, preferred, quarterly, 1½ per cent, payable Oct. 1.

Associated Gas & Electric Company, preferred, quarterly, 1½ per cent, payable Oct. 15.

Bell Telephone Company of Missouri, quarterly, 2 per cent, payable Oct. 1.

Bell Telephone Company of Pennsylvania, quarterly, 1½ per cent, payable Oct. 15.

Boston Suburban Electric Companies, preferred, quarterly, $1 per share, payable Oct. 5.

Cincinnati, Newport & Covington Light & Traction Company, preferred, quarterly, 1⅛ per cent; common, quarterly, ⅛ per cent, both payable Oct. 15.

Mexican Light & Power Company, quarterly, 1 per cent, payable Oct. 14.

National Carbon Company, quarterly, common, 1½ per cent, payable Oct. 15.

National Light, Heat & Power Company, preferred, quarterly, 1¼ per cent, payable Oct. 1.

New England Telephone & Telegraph Company, quarterly, 1½ per cent, payable Sept. 30.

Oklahoma Gas & Electric Company, preferred, quarterly, 1¾ per cent, payable Oct. 15.

Ottumwa (Ia.) Railway & Lighting Company, preferred, quarterly, 1¾ per cent, payable Oct. 15.

Philadelphia Company, quarterly, common, 1½ per cent, payable Nov. 1.

Public Service Corporation of New Jersey, quarterly, 1¼ per cent, payable Sept. 30.

San Diego (Cal.) Consolidated Gas & Electric Company, preferred, quarterly, 1¾ per cent, payable Oct. 15.

Standard Underground Cable Company, quarterly, 3 per cent, payable Oct. 10.

United Electric Securities Company, preferred, semi-annual, 3½ per cent, payable Nov. 1.

West Penn Traction Company, preferred, quarterly, 1½ per cent, payable Oct. 15.

REPORTS OF EARNINGS

	Gross Earnings.	Expenses.	Net Earnings.	Charges.	Surplus.
Cleveland, Southwestern & Columbus Railway Company:					
August, 1910	$103,754	$53,297	$50,457	$28,368	$22,089
August, 1909	90,718	50,964	39,754	26,824	12,930
Cumberland Telephone Company:					
August, 1910	571,855	322,490	249,365	49,603	199,762
August, 1909	522,544	300,979	321,564	41,938	179,625
Detroit United Railway Company:					
August, 1910	899,014	587,863	311,151	178,463	148,002
August, 1909	801,100	507,002	294,098	162,998	143,793
Fairmont & Clarksburg Traction Company:					
August, 1910	56,606	17,822	38,874	12,609	26,264
August, 1909	42,863	13,975	28,888	12,310	16,577
Fort Wayne & Wabash Valley Traction Company:					
July, 1910	133,796	73,350	60,446	45,216	15,230
July, 1909	123,547	72,385	51,162	44,614	6,547
Grand Rapids Railway Company:					
August, 1910	111,814	49,744	62,070	19,858	42,112
August, 1909	99,838	42,457	57,381	18,945	38,346
Keystone Telephone Company:					
August, 1910	93,990	47,206	46,790	24,266	12,524
August, 1909	89,923	44,920	45,003	26,343	18,600
Kings County Electric Light & Power Company:					
August, 1910	344,964	174,967	67,619	.....	.....
August, 1909	292,735	139,427	55,824	.....	.....
Lake Shore Electric Railway System:					
August, 1910	139,896	59,962	79,933	34,718	45,214
August, 1909	130,993	55,522	75,170	33,852	41,318
Norfolk & Portsmouth Traction Company:					
July, 1910	196,898	107,053	89,845	66,570	23,269
July, 1909	180,227	106,088	79,064	63,344	15,714
Philadelphia Company:					
August, 1910	1,559,234	979,733	579,461	.....	.....
August, 1909	1,442,896	947,844	495,052	.....	.....
Rio de Janeiro Tramway, Light & Power Company, Ltd.:					
August, 1910	1,027,931	495,829	532,102	.....	.....
August, 1909	673,220	388,965	284,255	.....	.....

General News

Construction News.

ALBERTVILLE, ALA.—The Sand Mountain Electric Company is reported to be contemplating the installation of new machinery.

MONTGOMERY, ALA.—The Montgomery Traction Company has awarded the contract for the construction of its new power house in Montgomery to the F. S. Royster Guano Company, of Norfolk, Va. The cost of the building is estimated at $14,000.

HEBER, ARK.—The plant and holdings of the North Arkansas Telephone Company are reported to have been purchased by L. E. Carmichael. The new owner, it is understood, will make improvements to the system.

ALHAMBRA, CAL.—The City Council has granted the Pacific Electric Railway Company, of Los Angeles, Cal., a fifty-year franchise to build an extension of its railway system in Alhambra.

BAKERSFIELD, CAL.—The Kern River Oil Fields, Ltd., is reported to have contracted with the San Joaquin Light & Power Company, of Fresno, Cal., to supply electricity to the amount of 2500 hp to operate the machinery in the oil fields of the company. It is understood that 200 motors are to be installed for the purpose of operating pumps, drills and other machinery.

BODIE, CAL.—Bids will be received by George Delury, county clerk, until Nov. 14 for the franchise applied for by the Hydro-Electric Company to erect and operate electric transmission lines in this county for a term of thirty years.

OROVILLE, CAL.—Stanward Logue has filed notice of appropriation of 20,000 cu. in. of water in the Middle Fork of the Feather River at a point 200 yards below the junction of the south branch of the river to be utilized for power development.

PARADISE, CAL.—W. H. Hanscom, of Paradise, has filed a notice of appropriation of 1500 miners' in. of water in Big Chico Creek, near Paradise. It is proposed to erect a 500-ft. concrete dam across the creek and to divert the water to be carried to a power house where electricity will be generated and distributed to the towns of Paradise, Orloff, Stirling, Concow and other places in this section.

RED BLUFF, CAL.—Notice of appropriation of 10,000 cu. in. of water in Mill Creek has been filed by T. H. Ramsey, manager of Cone ranch. The water will be diverted from the creek and carried in flumes to the Cone ranch, where it will be utilized to generate electricity.

REDLANDS, CAL.—The City Council has passed a resolution authorizing Mayor Strait to appoint a committee to confer with the Mayor and a committee of the trustees of San Bernardino regarding a proposal for the two cities to unite and build and operate a joint municipal electric light plant. The Redlands committee has been authorized to secure a price from the Southern California Edison Company on its distributing system in Redlands.

SACRAMENTO, CAL.—The Board of Supervisors has awarded a contract to the Pacific Gas & Electric Company to supply electricity for lighting the streets of the Curtis Oaks lighting district. The contract calls for twenty 200-cp arc lamps at $6.30 each per month, which is the same rate paid by the City of Sacramento for street lamps. Bids will soon be called for lighting the Highland Park district.

SALINAS, CAL.—Extensive improvements are contemplated by the Monterey Electric Light & Power Company in the next twelve months, which will involve an expenditure of about $500,000 and include the extension of the water system of Salinas and improvements to the gas service. The company has secured the right-of-way over the property of the Jacks Corporation for extension of its transmission line from Monterey to Salinas. It is expected that work will soon be resumed on construction of the line. John M. Gardiner is vice-president.

SAN BERNARDINO, CAL.—Bids will be received by the Board of Supervisors until Oct. 10 for a franchise applied for by the Pacific Light & Power Company for permission to construct and operate pole lines and other appliances for the transmission of electricity on the county roads for a term of forty years.

SAN FRANCISCO, CAL.—The Downtown Association is reported to be planning to install 140 electroliers in the downtown district of the city, to cost $16,000, work on which will commence soon.

SAN FRANCISCO, CAL.—Application has been made by the Gough Street Railroad Company for a charter to construct an electric railway in San Francisco to connect existing lines. The proposed railway will be about one mile long and will be operated as part of the United Railroads. The company will be capitalized at $60,000.

VISALIA, CAL.—The Mount Whitney Power Company is extending its transmission lines to McFarland. It is expected to have the line completed and in operation by Oct. 15.

DELTA, COL.—The Fairview Interurban Railroad Company has applied for a charter to construct an electric railway through the fruit and coal sections of Montrose and Delta counties. One branch will extend from Delta to Cedaredge and another to the coal mines at Fairview. A third line will extend from Delta along the California mesa. The company is to be capitalized at $250,000 and the incorporators are: Charles G. Montz, of Denver, Col.; Col. M. Zeigler, Henry Zeigler and Watson Zeigler, of Fort Collins, Col., and B. F. Hubbard, of Chicago, Ill.

FORT LUPTON, COL.—Plans are being considered for the construction of an electric interurban railway between Denver and Estes Park, via Fort Lupton. A company has been formed, known as the Denver & Greeley Interurban Railway. Business men of Lupton have already subscribed $15,000 toward the project. S. J. Rhodes, R. M. Barr and W. H. Davis, of Fort Lupton, Col., are interested.

WASHINGTON, D. C.—The Terminal Taxicab Company, 1225 Twentieth Street, Washington, D. C., would like to receive prices on equipment for electrical plants for charging storage batteries, etc.

MACON, GA.—The street lighting committee has reported to the City Council that fifty-five additional lamps will be required for the new territory recentlty annexed to Macon. The installation of the lamps will require an expenditure of about $4,000.

RICHLAND, GA.—Plans are being considered to increase the output of the municipal electric light plant at an early date. The new equipment will include an 80-hp Schofield boiler, a 100-hp Corliss engine and a 75-kw alternating-current generator. M. B. Brown is superintendent.

HONOLULU, HAWAII.—Contracts have recently been placed by the Honolulu Rapid Transit & Land Company for one 1500-hp Hamilton-Corliss, cross-compound engine to be direct connected to a 1000-kw, direct current, General Electric generator, Stratton steam separator, Cochran oil separator and Wheeler & Edwards condenser and air pump. The company is installing two 420-hp Stiring boilers with superheaters. C. H. Ballentyre is manager.

ELK RIVER, IDAHO.—The new timber cutting mill now being constructed by the Potlach Lumber Company, of Potlach, Idaho, in Elk River, will be equipped for electric motor drive throughout.

AMBOY, ILL.—The City Council has granted the Northern Illinois Light & Traction Company a twenty-year franchise to construct and operate an electric railway on Main Street.

CHICAGO, ILL.—Negotiations have been closed between the City of Chicago and the trustees of the Sanitary Drainage District of Chicago whereby the latter is to provide street lighting for the entire city. The Sanitary Drainage District is to take over the transmission lines owned and operated by the city. It is proposed to double the number of street lamps now in use.

JERSEYVILLE, ILL.—The Alton, Jacksonville & Peoria Railway Company has awarded the contract for the construction of the roadbed and bridging for the seventeen-mile extension of its railway from Godfrey to Jerseyville to J. J. Scott & Son, of St. Louis, Mo. The company is also contemplating the installation of a 500-kw unit to increase the output of its power plant to meet the present demands made upon it.

KANKAKEE, ILL.—The contract for the construction of the power plant of the Kankakee Power Company has been awarded to C. Hoertz & Son. The cost of the plant is estimated at about $40,000.

KIRKWOOD, ILL.—The Kirkwood Electric Company is planning to erect a transmission line to Monmouth, seven and one-half miles, where the company will purchase energy of the Monmouth Public Service Company, which will be transmitted at 6600 volts. When improvements are made a twenty-four-hour service will be established. J. F. Kyler is secretary.

PRINCEVILLE, ILL.—The municipal electric light plant was recently sold to E. L. Brown, owner of the Elmwood electric light plant, for $3,000.

GREENTOWN, IND.—Preparations are being made by the Greentown Telephone Company for rebuilding its telephone lines, which will include replacing the open wire with cables and running the lines through alleys as far as possible.

INDIANAPOLIS, IND.—City Engineer Klausmann is contemplating the installation of electric incandescent lamps in the residence district of the city where gas pipes are not laid. Bids have recently been received for vapor lamps, but if satisfactory arrangements can be made with the electric lighting companies electric lamps may be installed.

MARION, IND.—The City Council is reported to have voted to issue $75,000 in bonds, the proceeds to be used for the construction of a municipal electric light plant.

MAUCKPORT, IND.—The Eureka Telephone Company is reported to have increased its capital stock from $25,000 to $50,000. E. P. Windell is president of the company.

NEW ALBANY, IND.—The Indiana & Kentucky Power Company, recently incorporated with a capital stock of $50,000, proposes to take over the New Albany Woolen Mills, on Vincennes Street, which is to be converted into a manufacturing plant. The factory has about ten acres of floor space, which will be rented out to small manufacturing concerns with steam and electrical power, light and heat. The company also pro-

poses to establish a public warehouse. The officers of the company are: Adam Heimberger, president; H. Runyan, vice-president; George Summers, secretary, and C. W. Inman, treasurer.

CLEAR LAKE, IA.—The Mason City & Clear Lake Railway Company has been granted a franchise by the City Council to extend its railway in Clear Lake.

DAVENPORT, IA.—The Tri-City Railway & Light Company is reported to have authorized an issue of $20,000,000 in bonds, of which the proceeds of $10,000,000 will be used to refund outstanding obligations of the company; $2,000,000 will be used for extensions and improvements to its system during the next two years and the remaining $8,000,000 will be held for future requirements. The construction of the Muscatine Interurban Railway will be included in the expenditure during the next two years.

MAGNOLIA, IA.—It is reported that a special election will be held Oct. 11 to vote on the proposition to grant an electric light franchise to the Bullock Public Service Company. If the franchise is granted, the transmission line will be extended from Missouri Valley to Magnolia.

MARSHALLTOWN, IA.—Steps have been taken towards organizing an independent telephone company in Marshalltown. The new company will have a capital stock of from $75,000 to $100,000. W. H. Jones, M. E. Melvin and E. E. Benedict.

SPENCER, IA.—The contract for twenty-eight electroliers to be erected on Main Street has been awarded by the Council to the McDonnell Iron Works, of Des Moines. Efforts are being made to extend the system north on Main Street to Twentieth Street.

OAKLEY, KAN.—The Wesco Supply Company, of St. Louis, Mo., is reported to have secured the contract for the construction of the municipal electric light plant. Burns & McDonnell, Scarritt Building, Kansas City, Mo., are engineers.

RUSSELL, KAN.—The contract for the construction of the municipal electric light plant is reported to have been awarded to the Wesco Supply Company, of St. Louis, Mo. Burns & McDonnell, Scarritt Building, Kansas City, Mo., are engineers.

HOPKINSVILLE, KY.—The Kentucky & Tennessee Traction Company has petitioned for a charter for the purpose of constructing an electric interurban railway to connect Hopkinsville and Guthrie. Charles Vanderburg, of Toledo, Ohio, has charge of the preliminary work.

LOUISA, KY.—The Big Sandy Milling Company is reported to be in the market for dynamos with sufficient output to supply 100 lamps. John G. Burns, of Louisa, Ky., is secretary.

THIBODAUX, LA.—Contracts were awarded by the Board of Aldermen on Sept. 23 for the municipal electric light plant as follows: For power house to George Kettriham, at $4,950; for engine to the Diesel Engine Company, at $22,000; to the Fort Wayne Engineering & Manufacturing Company for pumps, at $7,125; Fort Wayne Electrical Works for wiring, at $1,012; for poles to A. C. Jones, of Opelousas, for $3,549.

BANGOR, MAINE.—John R. Graham, president of the Bangor Railway & Electric Company, is reported to have taken a sixty-day option ot the property of the James Walker Company at Basins Mills. The property has valuable water rights and if purchased by Mr. Graham will probably be used for the development of electricty.

SKOWHEGAN, MAINE.—The contract for the construction of a dam across the north channel of the Skowhegan River has been awarded by the Skowhegan Water Power Company to J. L. Parker & Son, of Fairfield, Maine. C. S. Humphreys, of Madison, Maine, is engineer.

SHARPSBURG, MD.—The City Council is reported to have accepted the proposition submitted by the Antietam Light & Power Company, of Boonsboro, Md., to install electric lamps in Sharpsburg. The company will also supply electricity for lamps for business places and residences.

BOSTON, MASS.—At a special meeting of the stockholders of the Massachusetts Lighting Company held recently the stockholders voted to increase the capital stock of the company by an issue of 8700 shares at $130 per share, the proceeds to be used for paying for the stock of the Gloucester Gas Light Company and the Lexington Gas Company, recently acquired, and for extensions to the various operating plants.

CHARTLEY, MASS.—The Norton Electric Light & Power Company has applied to the Legislature for a franchise to extend its service through East Norton.

COLRAIN, MASS.—The Greenfield Electric Light & Power Company has purchased the plant and holdings of the Colrain Electric Light Company and will take possession Nov. 1. It is understood that the present plant will be closed and electricity for operating the local system will be supplied from the Shelburne Falls plant.

GLOUCESTER, MASS.—The Oceanside Company has applied to the City Council for a franchise to erect and maintain electric transmission lines on certain streets in the Magnolia district for the purposes of supplying electricity for lamps. The company has recently installed an electric plant in the Hotel Oceanside, in Magnolia, for the purpose of lighting the hotel and the several cottages connected with the hotel. Charles E. Phenix is president of the company.

HAVERHILL, MASS.—Preparations are being made by the Haverhill Electric Company to extend its transmission lines to the Atkinson town line.

HAVERHILL, MASS.—The New Hampshire Electric Railways Company is contemplating the purchase of 500-hp boilers with superheaters and stokers. D. A. Belden is president.

MARLBORO, MASS.—The Boston & Western Electric Railway Company, of Boston, Mass., has applied to the town officials for a franchise to construct and operate an electric railway in Marlboro. The proposed railway will be about sixteen miles in length and will connect Marlboro, Weston, South Sudbury and Waltham. At South Sudbury a branch, five miles in length, will be built to connect with the main line at Maynard.

MILFORD, MASS.—The Milford & Uxbridge Street Railway Company is contemplating extending its railway from the present terminus in Uxbridge to Manchaug, a distance of fourteen miles, via Whitinsville and East Douglas.

PITTSFIELD, MASS.—The Berkshire Street Railway Company has awarded the contract for the construction of its power house in Zylonite to F. T. Ley & Company, of Springfield, Mass. The building will be 120 ft. x 150 ft. in size. The plant will cost about $75,000, and, it is understood, will supply electricity for the Bennington railway and the Greylock electric railway when completed.

SPRINGFIELD, MASS.—The City Council has appropriated $400 to be utilized by the street lighting committee to investigate different methods of street lighting with a view of improving the street lighting system in Springfield.

SWAMPSCOTT, MASS.—The contract for street lighting has been awarded to the Lynn Gas & Electric Company, of Lynn, Mass., for a period of five years. Under the terms of the contract the company is to suppply arc lamps as follows: For the first year, $73 each; second year, $72.50 each; third year, $72 each; fourth year, $71.50 each; fifth year, $71.50 each, and incandescent lamps at $17.50 each per year. The contract is based upon the service of 90 arc lamps of 1200 cp each and 120 incandescent lamps.

DETROIT, MICH.—Announcement has been made by the Pere Marquette Railway Company that telephones will be installed for train despatching on the Toledo-Saginaw division. If it proves satisfactory the entire system will be equipped with telephones. The cost of the work is estimated at about $16,500, and 140 miles of track will be equipped.

HOUGHTON, MICH.—The Calumet & Hecla Company is reported to be contemplating remodelling its Osceola stamp mill. The company is gradually replacing underground pumps with new motor-driven units, electricity for which is supplied from its electric plant at Lake Linden, Mich.

KALAMAZOO, MICH.—Plans are being prepared by the Lake Michigan and Kalamazoo Railroad Company for the construction of an electric railway from Kalamazoo to Benton Harbor, for which application for a charter has been made. The capital stock is placed at $25,000 and the officers are: William A. Baker, of Coloma, Mich., president; William C. Klumb, of Kansas City, secretary and treasurer, and John M. Notley, of Kalamazoo, Mich., attorney.

ST. CHARLES, MICH.—The City Council is reported to have decided to appropriate $14,000 for the construction of an electric light plant.

FARIBAULT, MINN.—It is reported that the Consumers' Power Company is planning to supply electricity in Faribault from its plant now under construction at Cannon Falls, Minn.

FERGUS FALLS, MINN.—It is reported that the Otter Tail Power Company, owing to the dry summer, is contemplating the installation of a large auxiliary steam plant. The headquarters of the company are located in Fergus Falls, Minn., but it is expected that the steam plant will be installed at Wahpeton, N. D., and supply electricity in Fergus Falls, Wahpeton and Breckenridge, Minn. It is expected to have the plant in operation by Dec. 1, 1910.

HATTIESBURG, MISS.—The Hattiesburg Traction Company is reported to be contemplating the construction of an extension to Laurel, a distance of about thirty miles.

APPLETON, MO.—A franchise has been granted to E. A. Hookas to erect and operate a telephone system for a term of twenty-five years.

COLUMBIA, MO.—At an election held Sept. 27 the citizens voted in favor of the proposition to issue $125,000 in bonds, the proceeds to be used for constructing an electric light plant and water-works system. As yet a superintendent for the plant has not been engaged. John S. Bicknell is city clerk.

MEXICO, MO.—A deal has been consummated whereby the Mexico Waterworks Company and the Mexico Electric, Heat & Power Company has been consolidated under the name of the Mexico Public Service Company. The new company is capitalized at $300,000. Negotiations have been closed whereby the company will supply electricity for lighting the Town of Centralia, fifteen miles distant. The directors are: S. M. Locke, E. R. Locke, P. E. Locke, Mary E. Locke and J. J. Steele.

MACON, MO.—It is reported that the Gary system will soon commence work on construction of toll lines from Macon to Sedalia, and St. Joseph to Hannibal.

ST. LOUIS, MO.—Following a decision handed down by the Circuit Court holding its franchise valid, the West End Light & Power Company is reported to have made arrangements to finance its undertaking. The company is operating a franchise obtained from Browning, King & Company granted by the city in 1885. Steps will be taken at once for building the plant. The company is operating a transmission line from Kings Highway to Sarah Street and is furnishing electricity for lamps to the Buckingham Club and residences in that vicinity. The company, it is said, will offer to supply electrical service at a lower rate than is

now supplied by the Union Electric Light & Power Company. Jesse D. Dana is president of the company.

ST. LOUIS, MO.—The Board of Public Improvements is considering plans for enlarging the power plant in the city hall, which supplies electricity for lighting the municipal buildings. Four different plans are under consideration, a change being necessary on account of the additional service required for the municipal courts building, when completed. The first plan is to enlarge the present plant in the basement of the city hall; the second is to erect another building, to be used especially for a light and heating plant; the third to construct a separate boiler house on a lot to be purchased in the Mill Creek Valley, where it would be convenient to a coal switch, and convert the entire space now used in the basement of the city hall to steam turbines and generators with steam sent through a pipe line from the boiler house; the fourth plan is to purchase energy from the Union Electric Light & Power Company and take out the electric apparatus from the city hall and use the space to enlarge the heating plant. If the last plan is adopted, the electric generators will be sent to the City Hospital plant, which is too small for the extra load it will have to carry when the new buildings are completed. The Union Electric Light & Power Company has submitted a proposition to the Board of Public Improvements offering to supply electricity for lamps and motors for the downtown group of city buildings as follows: For service up to 60,000 kw per month, at 2.17 cents per kw-hour; from 60,000 to 70,000 kw, for 2.06 cents per kw-hour; from 70,000 to 80,00 kw, at 1.99 cents per kw-hour, and 1.95 cents per kw-hour for all above 80,000 kw. It is estimated that the amount needed for the buildings, including the new municipal building, will be between 60,000 and 70,000 kw per month. The above rates do not include lamps or appliances. The city is now generating electricity at the city hall plant at a cost of 1.08 cents per kw-hour, which includes the cost of heating the city hall, but does not include such expenses as insurance and depreciation.

CHOUTEAU, MONT.—The Automatic Telephone Company is contemplating improvements to its system, including overhauling its exchange.

MILES CITY, MONT.—Contracts for the installation of machinery for the municipal electric light plant are reported to have been awarded as follows: For engine to Whiteacre & Company, of St. Paul, Minn., and electrical equipment to the General Electric Company, of Schenectady, N. Y.

BROCK, NEB.—Preparations are being made by the Farmers' Telephone Company to erect a telephone line to Julian for toll connections.

MILFORD, NEB.—The citizens are reported to be considering the installation of an electric power and pumping plant for municipal service.

BAYONNE, N. J.—It is reported that the Texas Company, 17 Battery Place, New York, N. Y., is contemplating the erection of a power plant at its works in Bayonne,

EDGEWATER, N. J.—The New Jersey Board of Public Utility Commissioners has approved of the proposed bond issue of the New Jersey & Hudson River Railway & Ferry Company of $100,000, the proceeds of which are to be used for the extension of its tracks and additions to its generating plant.

SWEDESBORO, N. J.—The Gloucester County Electric Company, of Pitman Grove, N. J., has applied to the Borough Council for a twenty-five-year franchise in Swedesboro.

FARMINGTON, N. M.—Extensive improvements are contemplated to the local electric light and power plant, which will include the erection of a new dam, an ice and cold-storage plant, concrete spillway, bulkheads, etc., which will involve an expenditure of about $100,000. R. L. Knowles is president of the company.

ROSWELL, N. M.—A new schedule of prices for electricity for lamps was put into effect Sept. 16 by the Roswell Gas & Electric Company, under which the average consumer will secure a reduction of 6⅔ per cent. The minimum cost has been reduced from $2 to $1.50 per month. For all bills paid by the 10th of the month the price is reduced from 15 cents to 14 cents per kw-hour. To large consumers a greater discount is given.

BROOKLYN, N. Y.—Bids will be received by C. B. J. Snyder, superintendent of school buildings, Department of Education, corner Park Avenue and Fifty-ninth Street, New York, N. Y., until Oct. 10 for installing electric equipment in new public school 167, located on Eastern Parkway, Schenectady Avenue and Lincoln Place, Brooklyn Borough.

BROOKLYN, N. Y.—The Public Service Commission has granted the Brooklyn Rapid Transit Company permission to begin work on an extension of its Church Avenue line from Rockaway Avenue through a section of East New York and Brownsville, known as the South Side. Application will be made to the borough officials for a permit to begin work on same.

EAST RANDOLPH, N. Y.—The Public Service Commission, Second District, has granted George B. Woodmancy, of Randolph, N. Y., permission to commence work on the construction of an electric light plant in the Village of East Randolph to supply electricity for lamps and motors in this village.

HORNELL, N. Y.—The Hornell Electric Company is installing a large boiler in its power plant on Hill Street and has prepared plans for extending its steam-heating system.

JAMESTOWN, N. Y.—The power house of the Salisbury Wheel Company, located on East Second Street, was destroyed by fire Sept. 21. The plant was leased to Frederick Sprague and supplied electricity for lighting the streets of Falconer, one of the suburban towns adjoining Jamestown. It is understood that the power plant will be rebuilt.

NEW YORK, N. Y.—The Fay Machinery Company, 126 Liberty Street, New York, N. Y., is reported to be in the market for a 75-kw, two-phase, 60-cycle, 2300-volt generator, belted. J. M. Fay is manager.

OGDENSBURG, N. Y.—Plans are being considered by the Long Sault Development Company to develop the water power of the South Sault channel of the St. Lawrence River, between Long Sault Island and the mainland, which is entirely American territory.

ONEIDA, N. Y.—The Rome & Oneida Electric Railway Company, which proposes to construct an electric railway to connect Rome and Oneida, via Verona, Blackman's Corners, Greenway and Hatch's Corners, thirteen miles in length, will apply to the City Council for a franchise to construct a railway in Oneida. D. C. Hadcock, of Oneida, N. Y., is promoter of the project.

ASHEVILLE, N. C.—Preparations are being made by the W. T. Weaver Power Company to extend its transmission lines to Canton, where it will furnish 1500 hp to the Champion Fibre Company to operate part of its plant. The Fibre company has a hydroelectric plant, which supplies power for a greater portion of the plant, also an auxiliary steam plant which is operated all the time. Owing to the expense of operating the steam plant the Champion company has decided to secure energy from the power company. The line will be erected from the plant on French Broad River and pass through the Juno and Leicester sections across Newfound Mountain to Canton and probably will be extended to Waynesville eventually. The W. T. Weaver Company is erecting an additional power plant on the French Broad River, below Marshall, at which 4000 hp will be developed. Electricity generated at this plant will be transmitted to the power house near Craggy, where it will be distributed.

SPRING HOPE, N. C.—D. L. Culpepper is reported to be interested in a project for the development of water power and the erection of a cotton mill on Tar River, six miles distanct from Spring Hope. It is estimated that 1000 hp can be developed.

WADESBORO, N. C.—Initial steps have been taken by A. H. Richardson, of Ansonville, N. C., and others toward the development of the northern section of the county. The plans include the construction of a large hydroelectric power plant near Kendall Ferry, in Rocky River, 15 miles north of Wadesboro. It is proposed to build a dam and power house at this point at a cost of about $400,000, and develop from 6000 to 7000 hp. The erection of a large cotton mill, near Ansonville, is also under consideration.

ALLIANCE, OHIO.—The Alliance-Akron Railroad Company is reported to have financed its project and plans are being made to commence work on the construction of its proposed railway this fall. The railway will be about twenty-six miles in length. Charles Keith is president of the company.

ATHENS, OHIO.—Bids will be received until Oct. 22 by the Board of Trustees of Athens State Hospital for furnishing and installing two 150-hp boilers, standpipe 22 ft. x 80 in., system of steam and water piping and hydrotherapeutic plant. For further information address the Osborne Engineering Company, consulting engineers, Cleveland, Ohio.

COLUMBUS, OHIO.—The ordinance providing for a vote at the November election on the question of issuing $225,000 in bonds to enable the municipal electric plant to supply electricity for commercial purposes and to light annexed territory was defeated by the City Council. A new measure asking for a $75,000 bond issue for the erection of substations and to purchase other equipment necessary to light the recently annexed territory will be introduced at the next meeting of the Council.

GALLIPOLIS, OHIO.—The Gallipolis telephone system was sold at auction Sept. 27 to E. L. Coen, of Vermillion, Ohio, for $14.450, which was two-thirds of the appraisement price.

LANCASTER, OHIO.—Sealed proposals will be received until Oct. 27 by the Board of Trustees of the Boys' Industrial School, Lancaster, Ohio, for furnishing and installing additional boilers for the light, heat and power plant at the institution. Plans and specifications are on file in the above office. Harold M. Bush, 69 North Fourth Street, Columbus, is engineer in charge of the work. F. C. Gerlach is secretary of board of trustees.

NELSONVILLE, OHIO.—Announcement has been made that the Hocking-Sunday Creek Traction Company will use electricity as motive power, instead of gasoline cars as first planned, on its proposed railway which is to connect Nelsonville, Gloucester and Athens, a distance of about thirteen miles.

MUSKOGEE, OKLA.—Plans are being considered by the Muskogee Industrial Development Company for the construction of a dam across the Grand River. Gov. C. N. Haskell is president of the company.

CORVALLIS, ORE.—The Portland, Eugene & Eastern Railway Company has applied to the City Council for a thirty-year franchise to construct and operate an electric railway in Corvallis.

LAKEVIEW, ORE.—Plans are being considered by the South Oregon Water Power Company to develop the water-power of Deep Creek in the vicinity of Adel. The installation will at first develop 2500 hp, but will ultimately generate 10,000 hp. Electricity generated at the plant will be used in Bakeview, Warner Valley, Surprise Valley, Cal., and Catalow Valley for municipal, manufacturing and irrigation purposes.

Charles McIntyre, engineer, of Spokane, Wash., is interested in the project.

MEDFORD, ORE.—Orders have been placed by the light committee of the City Council with the Rogue River Valley Electric & Power Company for the installation of thirty additional lamps on the streets in Medford and to change all the 16-cp incandescent lamps on East Main Street to arc lamps.

PANAMA.—Bids will be received at the office of the general purchasing officer of the Isthmian Canal Commission, Washington, D. C., until Oct. 27 for steel cable, portable electric grinder, etc. Blanks and general information pertaining to this circular (No. 608) may be obtained at the above office or at the offices of the assistant purchasing agents, 24 State Street, New York, N. Y.; 55 National Realty Building, New Orleans, La., and 1086 North Point Street, San Francisco, Cal.

ALLENTOWN, PA.—The Lehigh Valley Transit Company has recently secured franchises permitting the company to build a new electric railway from Quakertown to Perkasie. The company has operated its cars over the leased line of the old Quakertown Traction Company, which the Lehigh company has decided to cancel. The cost of the proposed new railway is estimated at about $200,000.

AVONDALE, PA.—The power house and boiler plant of the Pennsylvania Marble & Granite Company was destroyed by fire on Sept. 28, entailing a loss of about $25,000. Work will be suspended temporarily at the quarries, as the cranes and derricks were operated by electricity. A new building will be erected and machinery installed.

CARBONDALE, PA.—The New York, Ontario & Western Railway Company has awarded the contract for the erection of railroad shops at its Mayfield, Pa., yards, near Carbondale, to J. G. White & Company, 43 Exchange Place, New York, N. Y. The work will include a 10-stall roundhouse with turntable, machine shop with power plant complete, storehouse, oil building, and a complete coaling station with a storage capacity of approximately 1000 tons, at an estimated cost of about $150,000.

CARLISLE, PA.—Contracts have been awarded by the Cumberland Railway Company for the construction of a three-mile extension to the Tye Fork branch and also a three-mile extension of the main line to the Gibson-Carr Construction Company, of Middlesboro, Ky. An extension to reach Jellico, Tenn., a distance of twenty-seven miles, is also under consideration.

CHAMBERSBURG, PA.—Plans are being considered by local capitalists and residents of St. Thomas for the construction of an electric railway between Chambersburg and St. Thomas. The railway will be seven and one-half miles in length. It is said that as soon as $100,000 in capital stock is subscribed work will commence on construction of the road. A company was chartered four years ago under the name of the Chambersburg & Western and surveys were made.

CHESTER, PA.—The Philadelphia Electric Company, which controls the Beacon Light Company, of Chester, Pa., has purchased a site on the river front on which it will erect an overhead or an underground carrier system across the Reading Railway to facilitate the unloading of coal.

ELLWOOD CITY, PA.—The City Council has granted the Pittsburg, Butler, Slippery Rock & Grove City Railway Company a franchise to construct and operate an electric railway in Ellwood City. The company proposes to build a railway to connect Butler, Slippery Rock, Grove City, Prospect and West Liberty, a distance of twenty miles.

HARRISBURG, PA.—Sealed proposals will be received at the office of Board of Commissioners, Water and Lighting Department, Harrisburg, Pa., until Oct. 18 for furnishing and installing gas power and electric power pumping machinery, ready for continuous service, at the high service pumping station of the Water Department. Specifications, blanks, etc., can be obtained on application at the office of the commissioners. John A. Affleck is president of the commission.

HIGH SPIRE, PA.—The Borough Council has decided to light the borough by electricity. It is expected that the borough will erect its own distributing system and make arrangements with the Steelton Light, Heat & Power Company, of Steelton, Pa., for energy to be supplied from the York Haven plant.

LAIRDSVILLE, PA.—The Muncy Creek Telephone Company has increased the capital stock from $5,000 to $15,000. U. G. Boyer is secretary of the company.

LEBANON, PA.—The directors of the Ephrata & Lebanon Street Railway Company have financed the construction of a new electric railway between Ephrata and Lebanon, twenty-three miles long. The cost of the road is estimated at $400,000, work on which will begin this fall. George D. Krause, of Lebanon, is president.

MAUCH CHUNK, PA.—It is reported that a movement is under way by local capitalists for the construction of an electric railway from Lehighton to Slatington, a distance of nine miles.

McKEESPORT, PA.—The directors of the Pittsburg, McKeesport & Westmoreland Railway Company have decided to make extensions to the company's lines in McKeesport and Mifflin, amounting to about thirteen miles.

PHILADELPHIA, PA.—John Stafford is reported to have purchased a site at the corner of Chancellor and Camac Streets, on which he proposes to erect a power house to supply power to the hotel he is erecting on Walnut Street.

PHILADELPHIA, PA.—Preparations are being made by the Philadelphia & Western Railway Company for the construction of a branch line from the main division at a point between Villa Nova and Radnor, extending into West Conshohocken.

PHILADELPHIA, PA.—It is reported that George Sachsenmaier & Company, 1309 Race Street, Philadelphia, Pa., are in the market for a 15 or 20-hp, 208-volt, 60-cycle, single-phase generator (Wagner preferred), and a 100-kw, 220-volt, 60-cycle, three-phase alternator, standard make.

YORK, PA.—Extensive improvements are being made to the plant of the S. Morgan Smith Company, in York, Pa., including additions to the power plant and the installation of electric cranes. It is understood that a large part of the power plant equipment has already been purchased.

DILLON, S. C.—At an election held Sept. 27 the proposition to issue $15,000 in bonds for improvements and extensions to the municipal electric light plant was carried.

NEWBERRY, S. C.—It is reported that contracts have been placed by the Mollohon Manufacturing Company and the Newberry Cotton Mills with the Southern Power Company, of Charlotte, N. C., for electricity to operate their plants. It is understood that the service will be secured from the transmission line which the Southern Power Company is now preparing to erect. About 1200 hp will be required by the Mollohon mill and 500 hp by the Newberry mill to operate about one-third of its plant, the remainder operating by steam power.

WALHALLA, S. C.—The City of Walhalla is reported to be contemplating the installation of a municipal electric plant and would like to receive prices on equipment for same, including water wheel, alternating-current generator, switchboard, transformers, line material, etc.; water wheel to develop 450 hp under 60-ft. head. The street lighting system will require seven and one-half miles of wire. George L. Wilson is Mayor.

BELLEFOURCHE, S. D.—The electric plant of the Bellefourche Light, Heat & Power Company was recently destroyed by fire.

AUSTIN, TEX.—The Austin Electric Railway Company is contemplating extending its railway system to South Austin, a distance of about two miles.

CALVERT, TEX.—It is reported that the Calvert Water, Ice & Electric Lighting Company is contemplating making extension to its plant.

CLARKESVILLE, TEX.—The plant of the Clarkesville Light Company was destroyed by fire on Sept. 26, causing a loss of about $40,000. The city will be without electric service until the plant is rebuilt. The plant was insured for $25,000.

FLORESVILLE, TEX.—The installation of an electric light plant in Floresville is reported to be under consideration. For further information address L. G. Wilder, secretary of the Business Men's Club.

GONZALES, TEX.—Preparations are being made by the Gonzales Telephone Company to move its local exchange. It is understood that a new switchboard carrying 1000 drops will be installed.

LOCKNEY, TEX.—The electric light plant which is being installed by local capitalists is nearly completed and will soon be placed in operation.

SAN MARCOS, TEX.—The San Marcos Utilities Company is contemplating the erection of about six miles of new transmission lines and overhauling one Corliss engine. W. N. Joiner is manager.

TYLER, TEX.—J. L. Worthman Construction Company, of Beaumont, Tex., is reported to have submitted a proposition to the Tyler Commercial Club offering to construct an electric railway from Tyler to Paris, Tex., and to establish machine and repair shops in Tyler, in consideration of a bonus of $300,000 upon completion of the road.

KAMAS, UTAH.—Application has been filed with the state engineer by John A. Knight, of Woodland, Utah, to appropriate 15 cu. ft. of water of the Provo River, to be utilized for power purposes. Mr. Knight proposes to supply electricity for lamps and motors in Kansas and vicinity.

SALT LAKE CITY, UTAH.—Bids will be received by the Utah Light & Railway Company until Oct. 15 for the erection of a steel transmission line from Salt Lake City to Ogden. Plans and specifications can be seen at the office of the electrical engineer, 133 South West Temple, Salt Lake City, Utah.

RICHMOND, VA.—The Richmond & Henrico Railway Company is planning to build a power house on Lester Street, between Louisiana and Orleans Streets, at a cost of about $23,000.

RICHMOND, VA.—The Virginia Railway & Power Company has applied to the City Council for a franchise to extend its railway up Hanover or Stuart Avenues from Harrison Street to Kensington, thence along that thoroughfare to the Boulevard and beyond to Roseneath Road.

RICHMOND, VA.—The Richmond Power Company has applied to the City Council for a franchise to erect poles and wires and subways for the transmission of electricity from the Midlothian coal mines in Chesterfield to Richmond. Miles M. Martin is attorney for the company.

WILLIAMSBURG, VA.—Plans are being considered by the Board of Trustees of William and Mary College for the construction of a water and light system for the institution to cost about $25,000. The trustees have engaged Architect Wiley, of Lynchburg, Va., to prepare plans and specifications, after which bids will be called for.

BURDOIN HEIGHTS, WASH.—The Hamann Lumber Company has installed an electric plant in its mill to supply electricity for lighting its works and to furnish power for operating machinery for clearings on Kabekona Ranch.

ELLENSBURG, WASH.—In a report submitted to the City Council E. I. Butler, superintendent of the municipal electric plant, recommended the installation of arc lamps instead of cluster lamps in the business district as proposed.

NORTH YAKIMA, WASH.—It is reported that the officials of the North Coast Company, now building a railway across Washington, are contemplating operating a railway across the Cascade Mountain range by electricity. An electric power development is now under way at Packwood Lake, near the headwaters of Cowlitz River, about ninety miles from Spokane. The power plant with transmission lines to Tacoma, Seattle, North Yakima and other towns in Central Washington will cost about $3,000,000. The project is reported to be connected with the North Coast Railway for the purpose of supplying power to operate the trains across the Cascades. F. L. Pitman, of Spokane, Wash., is chief engineer.

SPOKANE, WASH.—The City Council is considering the question of installing a municipal electric power plant at the up-river pumping station. Under the proposed plan the city will be able to construct a plant with an output of 6000 hp at a cost of about $150,000. The proposed plant will furnish power to operate all the city's pumping machinery, which at the present time cost $28,000 annually.

SPRINGDALE, WASH.—The new street-lighting system has been completed and put into operation; the principal business and residence streets are lighted by electricity for the first time. The service is furnished by the Kulzer Electric Company, of Valley, Wash., which has supplied electricity in Springdale for two years. The Town Council has contracted with the company for the service for one year.

WALLA WALLA, WASH.—Bids will be received by the City of Walla Walla until Oct. 15 for lighting the streets of the city with 186 or more arc lamps beginning Nov. 1, 1910. Bidders are requested to submit proposals covering a period of three and five years from Nov. 1, 1910. T. D. S. Hart is city clerk.

CHARLESTON, W. VA.—The Kanawha Water & Light Company has recently installed one 500-hp Babcock & Wilcox boiler, and also has recently placed a contract with the Allis-Chalmers Company, of Milwaukee, Wis., for practically a duplication of its electrical equipment, including a 750-kw steam turbine set and one 200-kw, direct-current, motor generator set, together with additional pumping equipment. W. C. Davisson is treasurer.

SUMMERSVILLE, W. VA.—Application has been made to the Nicholas County Court by W. H. Campbell for a twenty-year franchise to construct and operate an electric light and power system in this city.

BELOIT, WIS.—It is reported that contracts have been awarded by the Beloit Iron Works for equipment for its new power plant as follows: For boilers to the Reliance Boiler Works, of Oshkosh, Wis.; to the C. & G. Cooper Company, for engine, and the General Electric Company for generator.

BELOIT, WIS.—The Gardner Machine Company, of Beloit, Wis., is reported to have equipped its new plant for electric motor drive throughout. It is understood that electricity for operating the plant will be secured from the Beloit Water, Gas & Electric Company. All equipment needed for the present is said to have been purchased.

BOYD, WIS.—The Yellowstone River Telephone Company is reported to be contemplating extending its telephone lines this fall.

GREEN BAY, WIS.—The plant of the Northern Hydro-Electric Power Company at High Falls is nearly completed and will soon be put in operation. The new plant will supply electricity to operate the interurban cars of the Green Bay Traction Company and for lighting and manufacturing purposes in Green Bay.

LA CROSSE, WIS.—At an election to be held Nov. 8, it is reported, that a proposition to issue $50,000 in bonds will be submitted to a vote, the proceeds to be used for the construction of a municipal electric light plant.

NEENAH, WIS.—It is reported that arrangements are being made to begin work on construction of the large power plant at Gardner dam, above Shawano, on the Wolf River. John I. Beggs, of Milwaukee, Wis., is said to be interested in the project.

OSHKOSH, WIS.—The Wisconsin Telephone Company is contemplating extending its telephone line from Oshkosh to Franklin, a distance of six miles.

EDMONTON, ALTA., CAN.—It is reported that the City of Edmonton is contemplating the development of the water power of the Athabasca River. It is proposed to utilize several of the falls on the Athabasca River, including Grand Rapids, Pelican Rapids, Stony Rapids and the Rap du Joli Falls. Engineer Fielding has been engaged by the city to investigate the proposition.

ST. VITAL, MAN., CAN.—Application has been made to the Municipal Council of St. Vital by Joseph Bernier, secretary of the Rural Railway Company, for a thirty-year franchise to construct and operate an electric railway in St. Vital. If granted a franchise the company agrees to build a railway five miles in length from either Winnipeg or St. Boniface.

WINNIPEG, MAN., CAN.—Bids will be received by the Board of Control until Oct. 20 for furnishing one 15-hp, 60-cycle, induction motor and silent chain drive for same.

BROCKVILLE, ONT., CAN.—It is reported that bids have been asked by the City of Brockville, Ont., for debentures, the proceeds of which will be used for improvements to the municipal light and power plant.

GUELPH, ONT., CAN.—On Sept. 26 two by-laws were carried by large majorities, one granting a franchise to the People's Railway Company and the other authorizing the City of Guelph to subscribe for $85,000 in capital stock of the company. Under the terms of the franchise the entire railway system connecting Guelph with Berlin, Elora, Fergus, Arthur, Hespeler and Puslinch Lake is to be completed by July, 1912. Work will commence at once on grading of the railway between Guelph and New Berlin. The road between Berlin and New Germany is well under way. A. W. Bugg, of Berlin, Ont., Can., is secretary.

HAMILTON, ONT., CAN.—The Canada Steel Company is reported to have decided to establish its plant in Hamilton. It is proposed to erect and equip a plant at a cost of about $400,000. The proposed plant will be equipped for electrical operation.

HAMILTON, ONT., CAN.—Mayor MacLaren and Controller Allen have succeeded in reaching a tentative agreement on certain points that have been in dispute between the City of Toronto and the Cataract Power Company for some years, under which the company has agreed to pay the city $14,000 for a period of three years under the street lighting arbitration award. The power contract of July 18, 1908, will be cancelled.

OTTAWA, ONT., CAN.—Bids will be received at the office of the Commissioners of the Transcontinental Railway, at Ottawa,, Ont., until Oct. 18, for equipment of a roundhouse at Lake Superior Junction, Ont., and for centrifugal pumps and motors required for the sewage pump house at the Winnipeg shops, Winnipeg, Man. Plans and specifications may be seen and full information obtained at the office of Gordon Grant, chief engineer, Ottawa, Ont., Can., and of S. R. Roulin, district engineer, St. Boniface, Man. P. E. Ryan is secretary of the commissioners.

ST. CATHARINES, ONT., CAN.—Plans are being considered by the Niagara, St. Catharines & Toronto Railway Company for building an extension of its railway from Fonthill to Fernwich.

TORONTO, ONT., CAN.—The Toronto Electric Light Company has obtained an injunction restraining the City of Toronto from erecting any more poles in connection with its hydroelectric system, or from stringing wires on those already erected.

TORONTO, ONT., CAN.—A report has been presented to the Board of Control by the city engineer and city solicitor recommending that the city construct electric surface railway lines on Gerrard Street, in North Rosedale, on St. Clair Avenue and in other newly annexed districts, comprising 9.7 miles of track. The cost of the work is estimated at $570,000, including $250,000 for overhead and track work and $320,000 for permanent pavements.

TORONTO, ONT., CAN.—It is reported that the Hydro-Electric Power Commission has decided upon further development and has applied to the interests which control the power production on the Trent Valley for power to be supplied in Cobourg, Whitby and other towns in the Midland district. With this extension the commission will cover the whole Province, the Ottawa Valley, St. Lawrence frontier, Midland district, Niagara power zone, Fort William and Port Arthur.

TORONTO, ONT., CAN.—The Canada Paper & Power Company, recently incorporated with a capital stock of $10,000,000, is reported to be closely allied to the Quebec & Lake St. John Railway, which is controlled by the Canadian Northern Quebec Railway system. It is understood that the company proposes to develop a water power on the Saguenay River, near Chicoutimi, where it is estimated that between 150,000 and 200,000 hp can be developed. William MacKenzie is reported to be interested in the project.

MONTREAL, QUE., CAN.—The Board of Control has awarded the contract for lighting the streets of the city to the Montreal Light, Heat & Power Company, for a period of ten years, to take effect on Nov. 1, 1910. Under the terms of the new contract the company is to furnish 572 6.6-amp arc lamps at $72.70 each per year, 1650 4-amp lamps at $63.15 each per year, 80-cp incandescent electric lamps at $23 each per annum, and 40-cp incandescent lamps at $16 per lamp per year. J. S. Morris, general manager of the Montreal Light, Heat & Power Company states that it will take six months to install the lamps and accessory station equipment and will involve an expenditure of at least $200,000.

WALLACE, SASK., CAN.—The Hypotheck Mining Company, which owns a mining property at Kingston, is reported to be contemplating the installation of electric power in its mines at a cost of about $12,000. Steam power is now being used.

DAWSON CITY, YUKON.—The power plant of the Northern Light, Power & Coal Company has been completed. The plant has an output of 9000 kw and cost $2,000,000.

MEXICO CITY, MEX.—The Mexico Tramways Company has been granted concessions by the Federal Government for the construction of two electric interurban railways; one to extend from Mexico City to Puebla, a distance of 129 miles, and the other from this city to Toluca, 32 miles in length.

New Industrial Companies.

THE AMERICAN GAS APPLIANCE COMPANY, of Indianapolis, Ind., has filed articles of incorporation for the purpose of manufacturing automatic gas igniters and other gas and electric appliances. The incorporators are: Henry T. Barker, Paul R. Stockton and Frank L. Gifford.

THE AUTOMATIC MOTOR & ENGINEERING COMPANY, of

Chicago, Ill., has been incorporated with a capital stock of $100,000 by A. C. Allen, A. E. Roof, G. T. Clithers and A. E. Church, of Chicago, Ill. The company proposes to manufacture engines and machinery.

THE CONDUIT MACHINE COMPANY, of New York, N. Y., has been chartered with a capital stock of $25,000 by D. A. Garber, J. B. Wolff and H. R. Burt, of New York, N. Y. The company proposes to do a general contracting business.

THE EDISON-BEACH CAR COMPANY, of Chicago, Ill., has been incorporated with a capital stock of $5,000 by William W. Wheatley, L. Wheatley and William S. Gore. The company proposes to manufacture electric batteries and appliances.

THE INDEPENDENT ELECTRICAL SUPPLY COMPANY, of New York, N. Y., has been chartered with a capital stock of $200,000 by H. H. Kabat, J. Snyder and A. W. Palmer, of New York, N. Y. The company proposes to do a general electrical engineering business and deal in electrical supplies.

THE ISBELL-CHAPMAN ELECTRICAL COMPANY, of Bowling Green, Ky., has been incorporated with a capital stock of $5,000 by William H. Isbell, W. W. Chapman and G. L. Mercer. The company proposes to deal in electrical equipment.

THE JAMES GOLDMARK COMPANY, of New York, N. Y., has filed articles of incorporation with a capital stock of $20,000 for the purpose of carrying on a general electrical engineering business. The incorporators are: Rupert Jencks, Richard V. Pell and Karl Ambrock, all of 83 Warren Street, New York, N. Y.

THE KOCH ELECTRICAL SUPPLY COMPANY, of Brooklyn, N. Y., has been incorporated with a capital stock of $5,000 by Benjamin F. Koch, Florence B. Koch, 1311 Sterling Place, Brooklyn, N. Y., and Herbert S. Slocum, 507 Fifth Avenue, New York, N. Y. The company proposes to manufacture and deal in electrical devices and appliances.

THE O'NEIL-BRUCE LIGHT COMPANY, of Memphis, Tenn., has been incorporated by H. T. Bruce, C. W. Churchill, Eugene Sutcliffe and others. The company proposes to manufacture and sell lamps.

THE POWELL ENGINE CORPORATION, of Brooklyn, N. Y., has been incorporated by L. P. Powell, R. W. Powell and C. L. McLaughlin, of Bensonhurst, N. Y. The company is capitalized at $50,000 and proposes to manufacture machinery, engines, automobiles, etc.

THE SHUR-ON TROLLEY GUARD COMPANY, of Buffalo, N. Y., has been incorporated with a capital stock of $25,000 by Henry J. Tiedt, 438 North Hamilton Street; Frank J. Nolan, 449 West Ferry Street, and Harold J. Young, 40 Winslow Avenue, all of Buffalo, N. Y. The company proposes to manufacture all kinds of appliances for electric cars.

THE WILSON MOTOR CAR COMPANY, of Newark, N. J., has been chartered with a capital stock of $50,000 by S. F. Wilson, J. Foley, Jr., of Newark, N. J., and G. A. Lutz, of Jersey City, N. J. The company proposes to manufacture motors, engines, machinery, etc.

New Incorporations.

HACKETT, ARK.—The Hackett Telephone Company has been incorporated with a capital stock of $5,000 by William Hastings and others.

AUGUSTA, GA.—The Greenville, Greenwood & Augusta Railway Company has been chartered with a capital stock of $1,000,000 to construct a railway from Augusta, Ga., to Greenville, S. C., via Greenwood, 125 miles in length. The incorporatorts are: Henry Briggs, Frank Hammond and J. P. Charles, of Greenville, S. C.; J. C. Fawcett and Henry Zimmerly, of New York, N. Y.

HAGERMAN, IDAHO.—The Hagerman Valley & Western Railway Company has been incorporated with a capital stock of $200,000 for the purpose of constructing a railway to be operated by electric, steam, compressed air, gasoline or other motive power. The directors are J. Morton, W. Coltharp, H. Stroud, W. Clifford, E. M. Bell and J. Stewart Clark.

BELLEVILLE, ILL.—Articles of incorporation have been filed for the St. Clair Traction Company with a capital stock of $2,500. The company proposes to construct an electric railway from Belleville to a point in the southeastern part of St. Clair County. The directors are: Edward L. Thomas, C. A. Heinzelman, L. D. Turner, Jr., and William A. Twenhoefel, all of Belleville, Ill.

ST. PAUL (P. O. ST. PETER), ILL.—The St. Paul Telephone Company has been incorporated with a capital stock of $2,400 by Louis Opfer, Henry Moeller, Jacob Yund, Henry Opfer, Jr., and William Wissman.

FRANKFORT, IND.—Articles of incorporation have been filed for the Logansport & Southern Traction Company by Owen C. Brumbough, Elmer E. Sheridan and James R. Brown. The company is capitalized at $25,000 and proposes to construct and operate an electric railway between Frankfort and Logansport.

GREENFIELD, IND.—The Gem Telephone Company has been incorporated with a capital stock of $4,500 for the purpose of building and operating a telephone system in Gem and Hancock counties. The directors are: L. N. Larabee, Albert Buesking and F. M. Thomas.

KOKOMO, IND.—Articles of incorporation have been filed for the Kokomo Public Utility Company with a capital stock of $10,000 for the purpose of operating a public utilities company. The directors are: George J. Marott, of Indianapolis, Ind.; John B. Carter and L. J. Kirpatrick, of Kokomo, Ind.

LA GRANGE, IND.—The Riverside Electric Company has been chartered with a capital stock of $10,000. The directors are: J. C. Cain, W. H. Cain and A. L. Cain.

LINTON, IND.—The Linton Mutual Telephone Company has been incorporated with a capital stock of $10,000 by David R. Scott, Likens Littell and others.

ONTARIO, IND.—The Riverside Electric Company has been incorporated with a capital stock of $10,000 for the purpose of constructing a plant to generate and transmit electricity for lamps, heat and motors. The incorporators are: John C. Cain, H. F. Cain and A. L. Cain.

HERNWOOD (R. F. D., GRANITE), MD.—The Hernwood Telephone Company has been organized to construct a telephone line between Hernwood and Pikesville, Md., a distance of nine miles. The incorporators are Albert Ferrell and others.

MINNEAPOLIS, MINN.—Articles of incorporation have been filed for the Minneapolis Northern Suburban Railway Company by Charles Sherman, John J. McCarthy, Paul J. Marvin, L. L. McCulloch and William Lampert. The company is capitalized at $250,000 and proposes to construct and operate an electric railway from Minneapolis to Little Falls.

SPRINGFIELD, MO.—Articles of incorporation have been filed for the Springfield & Eastern Railroad Company by Hector D. Mackay, president, and Mortimer M. Hollemback, chief engineer, both of Springfield, Mo. The company is capitalized at $2,000,000 to construct and operate an electric railway from Springfield to Carthage and Joplin, with a branch from Paris Springs, via Mount Vernon and Monett to Pierce City. The proposed railway will be about 100 miles in length.

CONCORD, N. H.—Articles of incorporation have been filed for the Central New Hampshire Power Company with a capital stock of $2,000,000. The company proposes to develop the water power of the Blackwater River and will establish power stations in Webster and Salisbury for the distribution and sale of electricity. The incorporators are: Nathaniel E. Martin, of Concord, N. H.; Edward C. Crosby, F. L. Houghton, Dennison Cowles, of Brattleboro, Vt., and Edwin D. Clough, of Concord, N. H.

JERSEY CITY, N. J.—The Sheridan County Electric Company has been organized in this city for the purpose of transmitting and distributing electricity. It is capitalized at $25,000 and the incorporators are: F. W. Longfellow, Riverdale-on-Hudson, New York City; A. Gregory, P. K. Walcott, Brooklyn, N. Y.; E. M. Southern, Staten Island, and others.

JERSEY CITY, N. J.—Articles of incorporation have been filed for the Indiana & Kentucky Power Company by H. O. Coughlan, S. A. Anderson and J. R. Turner, of Jersey City, N. J. The company is capitalized at $50,000 and proposes to construct and operate electric light, heat and power plants.

MILLVILLE, N. J.—The Millville, Tuckahoe & Ocean City Electric Transportation Company, of this city, has been incorporated with a capital stock of $100,000 to construct a fright and passenger electric railway between Millville and Ocean City.

LITTLE VALLEY, N. Y.—The Clean Interstate Telephone Company has been incorporated by E. M. Earley, A. Larkin, D. A. Allen, Olean E. Campbell, all of Little Valley, N. Y.

NORTH TARRYTOWN, N. Y.—The Philips Manor Electric Light Company has been chartered with a capital stock of $50,000 by E. P. Benjamin, of Tarrytown, N. Y.; D. Elder, Tompkinsville, N. Y., and H. V. M. Dennis, Jr., of New Brunswick, N. J. The company proposes to generate and distribute electricity.

PORT CRANE, N. Y.—Among the newly incorporated companies is the Fenton Telephone Company, organized to construct a telephone line between Port Crane and Chenango Forks. It is capitalized at $500, paid in, and the following directors have been elected: E. W. Neff, Alvah Shepardson, Harvey Grippen, of Port Crane, N. Y., and E. E. Mowrey, D. D. Engle, Chenango Falls, N. Y.

CLEVELAND, OHIO.—The Home Light & Ice Company has been chartered by J. R. Collins, E. J. Knott and others. The company is capitalized at $10,000.

CLEVELAND, OHIO.—The American Subway Company has been chartered with a capital stock of $200,000 to build and operate a subway for the transportation of passengers and freight in Cleveland, Ohio. The incorporators are: A. B. du Pont, John N. Stockwell, Jr., Fred C. Alber, E. C. Hibbs and C. A. Nau.

MILLERSPORT, OHIO.—Articles of incorporation have been filed for the Ohio State Interurban & Electricity Promoting Company by Albert E. Boone, H. A. Axline, Lawrence S. Climer, Levi Bright and E. O. Boone. The company is capitalized at $99,000 and proposes to construct an electric railway from Lake Erie to the Ohio River. Under its charter the company has the right to furnish heat, light and fuel.

JESTER, OKLA.—The Jester Telephone Company has been incorporated with a capital stock of $2,000 by W. F. Corder, A. W. Lock and L. J. McMinn, of Jester, Okla.

MOODYS, OKLA.—Articles of incorporation have been filed for the Moodys Telephone Company by W. Combs, W. T. Williams and Walter R. Gourd, directors, all of Moodys. The new concern is capitalized at $3,000, and proposes to build a system of rural telephones.

OKLAHOMA CITY, OKLA.—The Home Heating & Lighting Company has been incorporated with a capital stock of $100,000 by E. J. Dupree, J. D. Dupree, W. G. Croslen, W. E. Hudson and R. J. Morgan.

ALBANY, PA.—The Berks & Lehigh Telephone Company will apply

for a charter with a capital stock of $10,000 for the purpose of constructing a telephone line through Greenwich, Albany and Maxatawny townships in Berks County and points in Lehigh County. The incorporators are: William Y. Fetherolf, Jesse M. Lengel, Elmer J. Bachman and Edgar Greenawald. James S. Focht, of Albany, Pa., is secretary and treasurer.

BURGETTSTOWN, PA.—The Burgettstown Farmers Telephone Company, with an authorized capital stock of $5,000, has filed articles of incorporation.

DENVER, PA.—The Denver & Ephrata Telephone Company has been organized with the following officers: Silas E. Bard, president; John G. Mentzer, vice-president; Alvin W. Mentzer, secretary and treasurer. The company will apply for a charter with an authorized capital stock of $25,000. Exchanges will be established at Denver and Ephrata with connection with the Bell telephone system.

GREENVILLE, S. C.—The Home Light & Power Company has been chartered by local capitalists and W. S. Lee, of the Southern Power Company. The company is capitalized at $100,000 and proposes to furnish electricity for lamps and motors in Greenville. Energy for operating the system will be purchased from the Southern Power Company, of Charlotte, N. C. Thomas J. Arnold is president and treasurer of the company.

ARMOUR, S. D.—The Howard Telephone Company has been incorporated with a capital stock of $1,000 by John Staufer, of Tennis, S. D.; and Samuel Teske.

OKOBOJO, S. D.—The Little Bend Okobojo Telephone Company has been chartered with a capital stock of $24,000 by H. P. Knox, of Little Bend; W. H. Green and W. E. Jenkins, of Okobojo,, S. D.

TENNIS, S. D.—The Banner Telephone Company has been incorporated with a cap tal stock of $1,000 by John Staufer, of Tennis, S. D.; J. J. Ernesti, of Goudville, S. D., and Charles Schmidt, of Tennis, S. D.

ELIZABETHTON, TENN.—The Watauga Power & Lighting Company has been organized and the following officers elected: Lee F. Miller, president and treasurer; W. E. Hunter, vice-president, and J. H. Grayson, secretary and general manager. The company is erecting a large concrete dam on the Watauga River and has a contract to furnish electricity for lamps and motors in Bristol, Tenn. The dam will be 50 ft. in height and will develop about 3000 hp. W. J. Oliver, of Knoxville, has the contract for construction of the dam.

DONNA, TEX.—The Donna Gin & Power Company has been incorporated by A. F. Hester, J. L. Guernsey and B. H. Hooks. The capital stock of the company is placed at $8,000.

GATESVILLE, TEX.—Articles of incorporation have been filed for the Gatesville Light & Power Company with a capital stock of $15,000 by J. A. Gilcrist, C. F. Caruth and J. R. Raby.

LOGAN, UTAH.—The Cache County Amusement Company has been incorporated in Utah to construct an interurban railway through Cache County to Preston, Idaho. It is capitalized at $100,000, and the incorporators are: Leo Nielson, Logan; F. J. Gustin, J. H. Garrett and Finlay Brooks, Salt Lake City.

MOSIDA, UTAH.—The Mosida Telephone Company has filed articles of incorporation with the Secretary of State, with a capital of $2,500. The officers of the company are: L. B. Curtis, president; W. F. R. Mills, vice-president, and H. C. Allen, secretary and treasurer.

SALT LAKE CITY, UTAH.—The Blacksmith Fork Light & Power Company has been chartered with a capital stock of $100,000 for the purpose of developing water power in the Blacksmith Fork on Bear River. M. S. Browning is president; Alfred Budge, vice-president, and A. B. Irvine, secretary and treasurer.

ENOSBURG FALLS, VT.—Articles of incorporation have been filed for the Van Horne Electric Light & Power Company with a capital stock of $10,000.

ROANOKE, VA.—Articles of incorporation have been filed for the Foster Falls Power Company with a capital stock of $100,000. The charter of the company gives it the privilege of establishing dams and storage basins within 15 miles of Foster Falls, in Wythe or Pulaski counties; also to erect transmission lines and distribute power within 150 miles of that place, and to furnish electricity in the towns of Wytheville, Pulaski, Radford, Christiansburg and Salem and the City of Roanoke; Henry K. McHarg, of Stamford, Conn., is president; John B. Newton, vice-president, and J. W. Cure, secretary and treasurer.

SOUTH BEND, WASH.—The Twin City Electric Company has been incorporated with a capital stock of $10,000 for the purpose of supplying electricity in South Bend and Raymond, Wash. The incorporators are: J. B. Crary and J. B. Bridges.

SOUTH BEND, WASH.—Articles of incorporation have been filed for the Twin City Railway Company with a capital stock of $10,000 by J. B. Crary and J. B. Bridges. The company proposes to construct and operate an electric railway between Raymond and South Bend, Wash.

WESTON, W. VA.—The Buckhannon, Weston & Glenville Electric Railway Company has been incorporated to build an electric railway from Sago to Buckhannon, via Weston and Glenville. The incorporators are: S. C. Rusimell, L. H. Morrison, J. G. Hall, L. H. Treppett, W. H. Gaston, G. F. Day, C. E. White, D. O. B. Hall, of Buckhannon, and J. A. Crislip, of Clarksburg, W. Va.

OTTAWA, ONT., CAN.—The Ottawa, Rideau Valley & Brockville Railway Company has been granted a charter to construct an electric railway about sixty miles long from a point near Ironsides, Que, south through Ottawa and the counties of Carleton, Grenville and Leeds to Brockville, Ont., on the St. Lawrence River, opposite Morristown, N. Y., where connection will be made by ferry with the New York Central & Hudson River Railroad.

Personal.

MR. THOMAS A. EDISON was a guest at the luncheon given by Gimbel Brothers on the occasion of the opening of their new store in New York on Sept. 28.

MR. JAMES S. WEEKS, formerly superintendent of the Lyons (N. Y.) Gas Light Company, has been appointed superintendent of the Palmyra (N. Y.) Gas & Electric Company.

MR. E. K. FORD has been appointed commercial agent of the Albany Southern Railroad, Hudson, N. Y. Mr. Ford was formerly connected with the Wilkes-Barre Gas & Electric Company.

MR. JAY THORN has resigned his position as chief engineer of the Geneseo (N. Y.) Gas & Electric Company to enter the sales department of the Wayne County Electric Company, Lyons, N. Y.

MR. G. W. ROUNDS has been appointed general superintendent of the Tacoma Railway & Power Company, Tacoma, Wash., and has resigned as general superintendent of the Savannah (Ga.) Electric Company.

PROF. MORGAN BROOKS, of the electrical engineering department in the University of Illinois, has resumed his work after a year's leave of absence, during which he made a journey around the world for study and recreation.

MR. A. J. PURINTON has resigned as manager of the Toledo & Chicago Interurban Railway, Kendallville, Ind., to become general superintendent of the St. Joseph Railway, Light, Heat & Power Company, St. Joseph, Mo.

MR. T. D. JENSEN, for the last year with the Shawinigan Water & Power Company, at Montreal, has been appointed assistant in the department of electrical engineering of the engineering experiment station of the University of Illinois.

MR. NORMAN W. HARRIS, president of the Harris Trust & Savings Bank of Chicago and prominent in the financing of telephone and other public utility properties, has been elected a director of the American Telephone & Telegraph Company.

MR. L. B. WICKERSHAM, formerly general manager of the United Railways, Portland, Ore., has been appointed chief engineer of the company. His successor is Mr. C. A. Coolidge, recently appointed general manager of the Oregon Electric Railway, Portland.

MR. CHARLES H. COURSER, formerly with the Edison Electric Illuminating Company of Brooklyn, N. Y., has accepted a position with the New England Engineering Company, of 50 Church Street, New York City, and is at present superintending extensive additions being made to the plant of the Dayton (Ohio) Lighting Company.

MR. GUGLIELMO MARCONI has denied the report recently circulated that he was in bad health. Latest reports place him in the Argentine Republic, where he claims to have received wireless messages from Glace Bay, Nova Scotia, and Clifden, Ireland. The distance covered is estimated at 5600 miles, which represents the longest distance thus far reached.

MR. W. S. LEE, vice-president and general manager of the Southern Power Company, is now in Europe, where he will continue his investigations of electrochemical processes for extracting nitrogen from air for manufacturing fertilizer. The Guye process will soon be employed by the Southern Power Company at Great Falls, S. C., under the direction of Mr. Lee.

MR. JAMES M. KITE has been appointed by the New York Public Service Commission, Second District, engineer of its division of telephones and telegraphs. Mr. Kite completed an electrical engineering course in the Drexel Institute in Philadelphia. Shortly after graduation he entered the engineering department of the New York & Pennsylvania Telephone & Telegraph Company at Elmira, N. Y., and by successive promotions became assistant engineer and traffic engineer.

MR. E. L. BROCKWAY has resigned his position as superintendent of feeders of the Metropolitan Street Railway Company, of New York City, to accept a position as representative and construction engineer with Mr. T. J. Cope, of Philadelphia, electrical construction contractor and manufacturer of underground specialties. For the past twelve years Mr. Brockway has been engaged in the underground electric railroad work with the Metropolitan Street Railway Company, superintending the feeder system during the change from cable to electric.

MR. FRANCIS V. WILCOX has been appointed by the New York Public Service Commission, Second District, telephone and telegraph accountant in its division of telephones and telegraphs. Mr. Wilcox was selected by the legislative committee which investigated the question of placing telephones and telegraphs under the jurisdiction of the commission. He was for several years special auditor for the Consolidated

Frontier and Associated Telephone Companies, with offices at Buffalo, and was also formerly connected with the New York & Buffalo Auditing Company, examining accounts of various public service corporations.

MR. E. E. POTTER, general manager of the Seattle (Wash.) Electric Company, has been appointed executive head of the new Appraisal Department established at the home office of Stone & Webster, Boston, Mass., for work in connection with the appraisal of railroad and electric properties. Mr. Potter became connected with the Seattle Electric Company in November, 1907, as assistant to the late Mr. Howard F. Grant, who was then general manager of the company. In April, 1908, he was appointed manager of the Seattle Electric Company. His duties as manager began immediately following the financial depression of 1907, and continued through the preparations for the Alaska-Yukon-Pacific Exposition, as well as during the period of the Exposition. Mr. Potter was largely instrumental in organizing the Stone & Webster Club of Washington, which comprises in its membership officials and department heads of properties controlled by Stone & Webster in Seattle, Tacoma, Bellingham and Everett. Mr. Potter will assume his new duties on Oct. 15, 1910. His successor as manager of the Seattle Electric Company will be Mr. H. T. Edgar, at present manager of the Northern Texas Traction Company, Fort Worth, Tex.

Trade Publications.

INSULATING VARNISH.—Much interesting information relating to insulating properties of paraffine varnish is contained in bulletin No. 12 of the Dielectric Manufacturing Company, of St. Louis, Mo.

MOTOR FANS.—Ventilating fans driven by motors of either the alternating-current or the direct-current type are described briefly and listed in bulletin 27 of the Ilg Electric Ventilating Company, of Chicago.

SILENT CHAINS.—Booklet No. 102 of the Link Belt Company, Philadelphia, Pa., is devoted to silent chains for use with motor drives. Numerous illustrations are given of chains utilized in connection with motor-driven machine tools.

LIGHTING SUPPLIES.—Catalog No. 20 of the Crescent Company, 106 South Clinton Street, Chicago, Ill., is an illustrated price list containing brief descriptions of lamp guards, cord adjusters, soldering compounds, wireless clusters, and pendent fixtures.

ALTERNATORS.—The Ideal Electric & Manufacturing Company, Mansfield, Ohio, has issued bulletin No. 1051, dealing with revolving field alternators of the belt-driven type. These machines are designed for single, two or three-phase, in ratings ranging from 15 to 200 kw.

AIR COMPRESSORS.—The National Brake & Electric Company, Milwaukee, Wis., has issued publication No. 391, devoted to motor and belt-driven air compressors. Portable and stationary outfits for all classes of service, together with the necessary accessories, are described in detail.

VACUUM CLEANERS.—The Keller Manufacturing Company, Philadelphia, Pa., has issued a well-prepared pamphlet giving instructions for unpacking and installing its vacuum cleaners. Diagrams are given of both the vacuum piping systems and the electric circuits of the motors.

ARC LAMPS.—The Adams-Bagnall Electric Company, Cleveland, Ohio, has issued a leaflet giving illustrations and brief descriptions of its regenerative flame arc lamps. It is stated that the electrodes have a life varying from sixty hours with alternating current to seventy hours with direct current.

SWITCHES.—The Hart & Hegeman Manufacturing Company, Hartford, Conn., has issued Catalog G, illustrating the well-known H & H surface snap, push button, rotary floor and door switches. Included in the catalog are also bases, boxes, conduit fasteners, handles, mats, plates, receptacles and wall cases.

ELECTRIC VEHICLES.—The Waverley Company, Indianapolis, Ind., has issued an instructive bulletin giving specific information concerning the cost of maintaining an electric vehicle in actual service. The information given in the bulletin is based upon replies received to letters sent to various users of the Waverley electric vehicle.

SIGN FLASHERS.—Motor-driven switches intended for use in the circuits of electric signs are described briefly in bulletin and price list No. 7 of the Reynolds Electric Flasher Manufacturing Company, 191 Fifth Avenue, Chicago, Ill. Many illustrations are given of signs employing these switches which are now in active service.

DIRECT-CURRENT MOTORS.—Many hints relating to the proper selection of motors for driving machine tools are given in bulletin No. 391 of the Triumph Electric Company, Cincinnati, Ohio. These motors are of the direct-current, steel-frame type, and have been designed with special reference to obtaining the requisite strength with the minimum of weight.

WELDING MACHINES.—The Thomson Electric Welding Company, Lynn, Mass., has issued a neatly executed catalog illustrating and describing its welding machines arranged for various services. It is shown that electric welders are particularly useful in connection with the manufacture of carriages, bicycles, tools, wire, pipe, automobiles and various domestic appliances.

CENTRIFUGAL PUMPS.—The De Laval Steam Turbine Company, Trenton, N. J., has issued a 96-page book entitled "High Efficiency of Centrifugal Pumps," which contains a large amount of information relating to the testing of pumps. Numerous charts are shown of the results of such tests, the charts being interpreted particularly from the viewpoint of the engineer.

MINE TELEPHONES.—Much interesting information of an engineering nature concerning telephones of the mine type is given in bulletin No. 1000 of the Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y. The bulletin is well illustrated, views being given of iron-clad telephones, and diagrams are given of the circuits arranged with particular reference to use in mine installations.

BUSINESS NOTES.

KIEWERT COMPANY.—The Chicago office of the Charles L. Kiewert Company, maker of flaming arc lamps, has been removed from 110 South Clinton Street to 58 Plymouth Place (Manhattan Building). Mr. H. W. Fowzer is in charge.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, has announced the following change in address and management of its Chicago office: Mr. W. R. Bonham succeeds Mr. F. L. Merrill as manager of the office, which is located at No. 275 La Salle Street, instead of in the Manhattan Building, as formerly.

THE GOLDSCHMIDT THERMIT COMPANY.—On Oct. 1 Mr. E. Stutz, vice-president and general manager, retired from the direction of the Goldschmidt Thermit Company, to be succeeded in that post by Mr. William C. Cuntz. Mr. Cuntz brings to his position a thorough knowledge of the steel business and a wide acquaintance with steam and electric railway officials of the country, having been connected for eighteen years with the Pennsylvania Steel Company.

STONE & WEBSTER.—At their home office in Boston, Mass., Stone & Webster have established a new department which will be officially known as the "Appraisal Department," which has become necessary by reason of the growing business of the corporation in the appraisal of values and readjustment of franchises of many electric service and railway systems in the East and South. Stone & Webster were employed by the bondholders' reorganization committee of the Metropolitan Street Railway, of New York, in an advisory capacity, and have also been called on to appraise and fix values, earning capacity, etc., of many independent plants in other parts of the country, street railways, banks, and state railroad commissions. The executive head of the new department will be Mr. E. E. Potter, at present general manager of the Seattle (Wash.) Electric Company, who will take charge on Oct. 15.

THE CUTLER-HAMMER MANUFACTURING COMPANY.—Mr. George B. Katzenstein, Jr., has been appointed manager of the new heating appliance department of the Cutler-Hammer Manufacturing Company, with headquarters for the present in the Chicago office of that company. Mr. Katzenstein has been engaged in the development and marketing of electric heating appliances for many years. Formerly he was vice-president and general manager of the Consolidated Electric Appliance Company, of San Francisco, and he has devoted a great deal of attention to the heating of water by electricity. Very largely through his efforts the instantaneous type of electric water heater has been developed. In this apparatus the use of resistance wire is avoided, carbon electrodes being substituted. In securing one of the leading American specialists in electric heating, the Cutler-Hammer Company has placed its new department in strong hands.

DIRECTORY OF ELECTRICAL ASSOCIATIONS, SOCIETIES, ETC.

ALABAMA LIGHT & TRACTION ASSOCIATION. Secretary, Geo. S. Emery, 11 N. Royal St., Mobile, Ala. Third annual convention, Anniston, Ala., Nov. 21, 22 and 23, 1910.

AMERICAN ASSOCIATION OF ELECTRIC MOTOR MANUFACTURERS. Secretary, W. H. Tapley, Engineering Societies Building, 29 West 39th St., New York. Next meeting (semi-annual), Chicago, Nov. 14, 15 and 16, 1910.

AMERICAN ELECTROCHEMICAL SOCIETY. Secretary, Prof. J. W. Richards, Lehigh University, South Bethlehem, Pa.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION. Secretary, Dr. J. Willard Travell, 27 East 11th St., New York.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Secretary, Ralph W. Pope, Engineering Societies Building, 33 West 39th St., New York. Meetings, second Friday of each month, excepting June, July, August and September.

AMERICAN STREET & INTERURBAN RAILWAY ACCOUNTANTS' ASSOCIATION. Secretary, H. E. Weeks, Davenport, Ia. Next meeting, Atlantic City, N. J., Oct. 10-14, 1910.

AMERICAN STREET & INTERURBAN RAILWAY ENGINEERING ASSOCIATION. Secretary, John W. Corning, Boston Elevated Railway Company, Boston, Mass. Next meeting, Atlantic City, N. J., Oct. 10-14, 1910.

AMERICAN STREET & INTERURBAN RAILWAY ASSOCIATION. Secretary H. C. Donecker, Engineering Societies Building, 29 West 39th St., New York. Next meeting, Atlantic City, N. J., Oct. 10-14, 1910.

ARKANSAS ASSOCIATION OF PUBLIC UTILITY OPERATORS. Secretary, J. E. Cowles, Little Rock, Ark.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS. Secretary, G. H. Winslow, 509 Perry-Payne Building, Cleveland, Ohio. Next meeting, Pittsburg, Pa., Oct. 17-20, 1910.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS. Secretary, P. W. Drew, 135 Adams St., Chicago. Next meeting, Boston, Mass., June, 1911.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS. Secretary, J. Andreucetti, Chicago & Northwestern Ry., Chicago. Next annual meeting, Chicago, November, 1911. Semi-annual meeting, Washington, 1911.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Secretary, N. T. Wilcox, Lowell, Mass.

CANADIAN ELECTRICAL ASSOCIATION. Secretary, T. S. Young, 104 Confederation Life Building, Toronto, Ont.

CANADIAN STREET RAILWAY ASSOCIATION. Secretary, Allen H. Royce, 48 King St., W., Toronto, Ont.

CENTRAL ELECTRIC RAILWAY ASSOCIATION. Secretary, A. L. Neereamer, Indianapolis, Ind.

CHICAGO ELECTRICAL SHOW. Manager, H. E. Niesz, 150 Michigan Boulevard, Chicago. Next show, Jan. 7-21, 1911.

COLORADO ELECTRIC LIGHT, POWER & RAILWAY ASSOCIATION. Acting Secretary, F. D. Morris, 323 Hagerman Bldg., Colorado Springs, Col.

EASTERN STATES INDEPENDENT TELEPHONE ASSOCIATION OF PENNSYLVANIA, NEW JERSEY, MARYLAND AND DELAWARE. Secretary, H. E. Bradley, 135 South Second St., Philadelphia, Pa.

ELECTRIC VEHICLE AND CENTRAL STATION ASSOCIATION. Secretary, H. T. Sands, 139 Pleasant St., Malden, Mass.

ELECTRIC CLUB, Chicago. Secretary, F. S. Hickok, 824 Marquette Building, Chicago. Meets every Wednesday noon, 303 Wabash Ave.

ELECTRIC CONTRACTORS' ASSOCIATION OF NEW YORK STATE. Secretary, Geo. W. Russell, Jr., 25 West 42d St., New York. Next meeting, Albany, N. Y., Jan. 17, 1911.

ELECTRIC TRADES ASSOCIATION OF PHILADELPHIA. Secretary, J. W. Crum, 1324 Land Title Building, Philadelphia, Pa. Meetings, second and fourth Thursday of each month.

ELECTRICAL CONTRACTORS' ASSOCIATION OF STATE OF MISSOURI. Secretary, Ernest S. Cowie, 1413 Grand Ave., Kansas City, Mo.

ELECTRICAL SALESMEN'S ASSOCIATION. Secretary, Francis Raymond, 125 Michigan Ave., Chicago. Annual meeting, Chicago, January, each year.

ELECTRICAL TRADES ASSOCIATION OF CANADA. Secretary, William R. Staveley, Royal Insurance Building, Montreal, Can.

ELECTRICAL CREDIT ASSOCIATION OF CHICAGO. Secretary, Frederic P. Vose, Marquette Building, Chicago. Next annual meeting, Chicago, Nov. 3, 1910.

ELECTRICAL TRADES ASSOCIATION OF THE PACIFIC COAST. Secretary, Albert H. Elliott, Harding Building, 34 Ellis St., San Francisco, Cal. Monthly meeting, San Francisco, second Thursday of each month.

ELECTRICAL TRADES SOCIETY OF NEW YORK (Member National Electrical Credit Association). Secretary Franz Neilson, 80 Wall St., New York. Board of Directors meets second Thursday of each month.

EMPIRE STATE GAS & ELECTRIC ASSOCIATION. Secretary, Charles H. B. Chapin, Engineering Societies Building, 29 West 39th St., New York.

ENGINEERING SOCIETY OF WISCONSIN. Secretary, W. G. Kirchoffer, 31 Vroman Building, Madison, Wis.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES. Secretary, C. H. Lembower, Reading, Pa.

FLORIDA ELECTRIC LIGHT & POWER ASSOCIATION. Secretary, H. C. Adams, West Palm Beach, Fla. Next meeting, Jacksonville, Fla., April 4 and 5, 1911.

ILLINOIS STATE ELECTRICAL ASSOCIATION. Secretary, H. E. Chubbuck, Peoria, Ill.

ILLUMINATING ENGINEERING SOCIETY. Secretary, P. S. Millar, Engineering Societies Building, 29 West 39th St., New York. Sections in New York, New England, Philadelphia and Chicago. Annual convention, Baltimore, October 24 and 25, 1910.

INDEPENDENT ELECTRICAL CONTRACTORS' ASSOCIATION OF GREATER NEW YORK. Secretary, L. H. Woods, 2355 Jerome Ave., New York.

INDEPENDENT TELEPHONE ASSOCIATION OF SOUTHERN INDIANA. Secretary, E. W. Landgrebe, Huntington, Ind.

INDIANA ELECTRIC LIGHT ASSOCIATION. Secretary, J. V. Zartman, Indianapolis, Ind.

INTERNAL COMBUSTION ENGINE ASSOCIATION. Secretary, Chas. Kratch, 416 W. Indiana St., Chicago. Meetings, second Friday of each month.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Secretary, C. R. George, Houston, Tex. Next meeting, St. Paul, Minn., 1911.

INTERNATIONAL ELECTROTECHNICAL COMMISSION (international body representing various national electrical engineering societies contributing to its support). Secretary, C. le Maistre, 28 Victoria St., Westminster, London, S. W., England.

INTERNATIONAL INDEPENDENT TELEPHONE ASSOCIATION. Secretary, A. C. Davis.

IOWA ELECTRICAL ASSOCIATION. Secretary, W. N. Keiser, Dubuque, Ia. Next meeting, Davenport, Ia., April, 1911.

IOWA INDEPENDENT TELEPHONE ASSOCIATION. Secretary, W. J. Thill, 208 Des Moines Life Building, Des Moines, Ia. Annual meeting, second Wednesday in March each year.

IOWA STREET & INTERURBAN ASSOCIATION. Secretary, L. D. Mathes, Dubuque, Ia. Next meeting, Davenport, Ia., April, 1911.

KANSAS GAS, WATER & ELECTRIC LIGHT ASSOCIATION. Secretary, James D. Nicholson, Newton, Kan. Next meeting, Independence, Kan., Sept. 21 and 22, 1911.

KENTUCKY INDEPENDENT TELEPHONE ASSOCIATION. Secretary, James Maret, Mount Vernon, Ky. Regular meeting, second Tuesday in October, each year.

MAINE ELECTRICAL ASSOCIATION. Secretary, Fred D. Gordon, Auburn, Maine.

MASSACHUSETTS STREET RAILWAY ASSOCIATION. Secretary, Charles S. Clark, 70 Kilby St., Boston, Mass. Meets second Wednesday of each month, except July and August.

MICHIGAN ELECTRICAL ASSOCIATION. Secretary, A. P. Biggs, Detroit, Mich.

MINNESOTA ELECTRICAL ASSOCIATION. Secretary, B. W. Cowperthwait, Faribault, Minn.

MISSISSIPPI ELECTRIC ASSOCIATION. Secretary, J. A. Abbott, Jackson Railway & Light Company, Jackson, Miss.

MISSOURI ELECTRIC, GAS, STREET RAILWAY & WATER ASSOCIATION. Secretary, N. J. Cunningham. Next meeting, St. Louis, April, 1911.

MISSOURI INDEPENDENT TELEPHONE ASSOCIATION. Secretary, G. W. Schweer, Windsor, Mo. Next meeting, St. Louis, May, 1911.

NATIONAL ARM, PIT & BRACKET ASSOCIATION. Secretary, J. B. Magers, Madison, Ind.

NATIONAL DISTRICT HEATING ASSOCIATION. Secretary D. L. Gaskill, Greenville, Ohio.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Executive Secretary, T. C. Martin, Engineering Societies Building, 33 West 39th St., New York.

NATIONAL ELECTRIC CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Secretary, W. H. Morton, 41 Martin Building, Utica, N. Y.

NATIONAL ELECTRICAL INSPECTORS' ASSOCIATION. Secretary, T. H. Day, 27 Pliny St., Hartford, Conn. Next meeting, New York, March, 1911.

NATIONAL ELECTRICAL CREDIT ASSOCIATION. Secretary, Fred P. Vose, 1343 Marquette Building, Chicago.

NEBRASKA ELECTRICAL ASSOCIATION. Secretary, Frank McMaster, Beatrice, Neb.

NEW ENGLAND STREET RAILWAY CLUB. Secretary, John J. Lane, 12 Pearl St., Boston, Mass. Meets last Thursday of each month.

NEW ENGLAND ELECTRICAL TRADES ASSOCIATION. Secretary, Alton F. Tupper, 84 State St., Boston, Mass. Directors meet first Wednesday of each month.

NEW ENGLAND SECTION, NATIONAL ELECTRIC LIGHT ASSOCIATION. Secretary, L. D. Gibbs, 39 Boylston St., Boston, Mass.

NEW ORLEANS ELECTRICAL CONTRACTORS' ASSOCIATION. Secretary, I. G. Marks, 312 Carondelet St., New Orleans, La. Meetings, second and fourth Tuesdays of each month.

NEW YORK ELECTRICAL SOCIETY. Secretary, G. H. Guy, Engineering Societies Building, 33 West 39th St., New York.

NEW YORK ELECTRICAL SHOW, Oct. 10-20, 1910. General Manager, Geo. F. Parker, 124 W. 42d Street, New York.

NORTHWEST ELECTRIC LIGHT & POWER ASSOCIATION. Secretary, N. W. Brockett, Cataract Building, Seattle, Wash.

OHIO ELECTRIC LIGHT ASSOCIATION. Secretary, D. L. Gaskill, Greenville, Ohio.

OHIO INDEPENDENT TELEPHONE ASSOCIATION. Secretary, Ralph Reamer, Columbus, Ohio.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL & STEAM ENGINEERS. Secretary, Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio. Next meeting, Nov. 18 and 19, 1910.

OKLAHOMA PUBLIC UTILITIES ASSOCIATION. Secretary, Galen Crow, Guthrie, Okla.

OLD TIME TELEGRAPHERS' & HISTORICAL ASSOCIATION. Secretary, F. J. Scherrer, 195 Broadway, New York. Next reunion, Atlantic City, N. J., 1911.

ORDER OF REJUVENATED SONS OF JOVE. Mercury (Secretary), R. M. Van Vleet, 1157 Monadnock Building, Chicago, Ill. Annual meeting, Birmingham, Ala., Oct. 13, 14 and 15, 1910.

PACIFIC COAST ELECTRIC VEHICLE ASSOCIATION. Secretary, A. H. Halloran, 604 Mission St., San Francisco, Cal.

PENNSYLVANIA ELECTRIC ASSOCIATION. Secretary, Van Dusen Rickert, Pottsville, Pa.

PENNSYLVANIA STREET RAILWAY ASSOCIATION. Secretary, Charles H. Smith, Lebanon, Pa.

PIKE'S PEAK POLYTECHNIC SOCIETY, Secretary, E. A. Sawyer, Colorado Springs, Col. Meetings, second Saturday of each month.

PITTSBURG ELECTRIC BOOSTER CLUB. Recording Wattmeter, O. R. Rombach, 919 Liberty Ave., Pittsburg, Pa. Meetings, fourth Monday of each month.

RAILWAY ELECTRIC SUPPLY MANUFACTURERS' ASSOCIATION. President, A. C. Moore, Safety Car Heating & Lighting Co., Chicago.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Secretary, H. H. Norris, Cornell University, Ithaca, N. Y.

SOCIETY OF WIRELESS TELEGRAPH ENGINEERS. Secretary, E. D. Forbes, Box 63, Brant Rock, Mass. Monthly meeting, first Monday of each month.

SOUTH DAKOTA INDEPENDENT TELEPHONE ASSOCIATION. Secretary, E. R. Buck, Hudson, S. D. Next meeting, Redfield, S. D., Jan. 11 and 12, 1911.

SOUTHWESTERN ELECTRIC & GAS ASSOCIATION. Secretary, E. T. Moore, Dallas, Tex.

STREET RAILWAY ASSOCIATION OF THE STATE OF NEW YORK. Secretary, C. G. Reel, Kingston, N. Y.

UNDERWRITERS' NATIONAL ELECTRICAL ASSOCIATION. Secretary Electrical Committee, C. M. Goddard, 141 Milk St., Boston, Mass. Next biennial meeting, March, 1911.

VERMONT & NEW HAMPSHIRE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, Lena M. Owen, St. Johnsbury, Vt.

Vermont Electrical Association. Secretary, A. B. Marsden, Manchester Center, Vt.

Washington Electrical Show, October or November, 1910.

Western Association of Electrical Inspectors. Secretary, W. S. Boyd, 145 Monroe St., Chicago, Ill. Next meeting, Omaha, Neb., October, 1910.

Western Society of Engineers. Electrical Section, formerly Chicago Electrical Association. Secretary, J. H. Warder, 1737 Monadnock Block, Chicago. Regular meetings, first Friday of each month, except January, July and August. Annual meeting, first Tuesday after Jan. 1, each year.

Wireless Institute. Secretary, Sidney L. Williams, 42 Broadway, New York.

Wisconsin Electrical Association. A consolidation of the Northwestern Electrical Association and the Wisconsin Electric and Interurban Railway Association. Secretary, John S. Allen, Lake Geneva, Wis.

Weekly Record of Electrical Patents

UNITED STATES PATENTS ISSUED SEPT. 27, 1910.

[Conducted by W. F. Bissing, Patent Law, 2 Rector St., N. Y. City.]

971,056. SYNCHRONOUS INDUCTION MOTOR; C. A. Lohr, Chicago, Ill. App. filed Oct. 29, 1906. Alternating rotary field motor in which the stator and rotor are connected with an alternating source giving a synchronous speed equal to the sum or difference of the rotary fields in the two motor members, including an auxiliary polyphase winding producing a magnetic field of half the number of poles produced by the main winding.

971,082. CIRCUIT BREAKER; F. L. Sessions, Columbus, Ohio. App. filed Aug. 6, 1903. Two or more electrical devices in a single circuit with a series parallel controller between the devices and circuit and a circuit breaker for the single circuit with two or more actuating coils, each connected to the said translating devices.

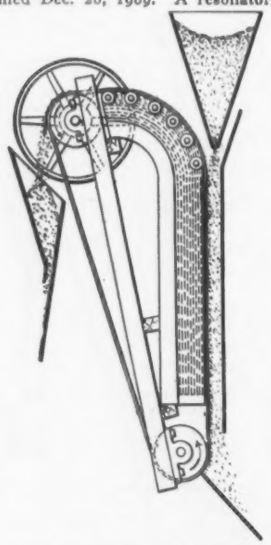
971,101. ELECTRIC HEATING UNIT; T. Van Aller, Schenectady, N. Y. App. filed July 23, 1908. A resistance ribbon wound into a closed helix and flattened onto itself.

971,124. PROTECTIVE SCREEN FOR APPARATUS WHICH IS EXPOSED TO HIGH TEMPERATURES; G. Egly, Treptow, near Berlin, Germany. App. filed Feb. 24, 1910. For pyrometers in which a protecting screen composed of silicon, carbon and nitrogen surrounds the heater.

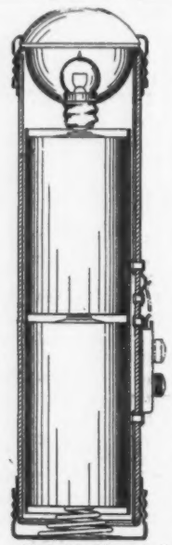
971,148. DIFFERENTIAL SPEED MOTOR; H. A. Rhodes, Denver, Col. App. filed July 20, 1909. A motor with its two members rotating in reverse direction and equipped with central annular bearing rings and a third member in opposite relation with the rings to utilize the differential speed of the two members and a shaft upon which the third member is mounted.

971,163. MAGNETIC SEPARATOR; B. E. Wood, Colorado Springs, Col. App. filed Dec. 27, 1909. For removing magnetic sand from gravel by means of an electromagnet, with anti-friction wheels and rolls arranged in the rear of the magnet body and also below the lower end and an endless non-magnetic apron on the rolls.

971,160. AUTOMOBILE HORN; L. B. Buchanan, Woburn, Mass. App. filed Dec. 20, 1909. A resonator with a vibratory snapper plate and



971,163.—Magnetic Separator.



971,241.—Portable Electric Lamp.

a vibratory actuating lever for the plate with electrical means for vibrating said lever.

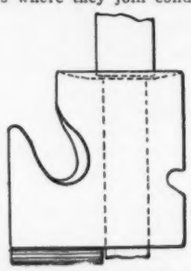
971,184. VOLTAGE REGULATOR; R. Fleming, Lynn, Mass. App. filed July 23, 1908. A line carrying an alternating current, a regulating device and means for making the latter unaffected by change of frequency on the line by varying the inductive relation between a movable series coil and a fixed set of shunt coils, the displacement of the series coils being controlled by the repulsion between two other coils placed in inductive relation to each other, one coil being short-circuited and the other charged by the line so that the current induced in the short-circuited coil varies with the line voltage, which varies the repulsive force exerted between the coils.

971,198. PROCESS FOR THE MANUFACTURE OF METALLIC SODIUM; P. L. Hulin, Grenoble, France. App. filed Oct. 27, 1908. Process for manufacturing metallic sodium by subjecting fused caustic soda to electrolysis, withdrawing the cathode periodically and bringing it into contact with water to restore its efficiency, replacing it and continuing the electrolytic action.

971,199. SYSTEM OF MOTOR CONTROL; L. Janisch, Berlin, Germany. App. filed Sept. 1, 1909. For controlling the speed of electric motors used to propel vehicles and supplied with current from storage batteries. The batteries are first connected in parallel for starting and in series for running and a protected resistance is inserted when changing from series to parallel.

971,205. FUSE MOUNTING; W. Merz, New York, N. Y. App. filed Oct. 28, 1907. A tubular shell with a molded metal cap at one end, a terminal bolt in the cap and a fuse wire passing through the shell and electrically connected to the bolt.

971,216. FITTING FOR ELECTRIC CONDUITS; W. C. Robinson, Pittsburgh, Pa. App. filed May 29, 1909. A metallic cap for enclosing branch conductors where they join conductors enclosed in a con-



971,322.—Mine Insulator.

duit, having resilient gripping portions to clamp the conduit on opposite sides of the junction and an opening in the cap for the branch conductors and a lining of insulating material within the cap near the junction.

971,237. TELEPHONE; J. W. Atlee, Riverton, N. J. App. filed June 4, 1908. A stand with a bracket, the latter carrying a sound amplifier or horn, and also holding the receiver in position to communicate with the horn, instead of it being necessary to hold the receiver by hand.

971,241. PORTABLE ELECTRIC LAMP; J. Block, New York, N. Y. App. filed Feb. 21, 1910. A portable electric lamp with a circuit closer comprising a fixed plate and a two-part box comprising a second fixed plate and an upper slotted section with prongs for securing it to the plate, a slotted spring tongue within the box to which a threaded pin is secured.

971,244. APPARATUS FOR OZONIFYING; C. S. Bradley, New York, N. Y. App. filed Oct. 29, 1906. Electrodes, dielectrics, corner blocks on the electrodes and clamps for the parts with funnels secured at the ends of the electrodes by the corner block, with means for maintaining the pressure below atmospheric.

971,307. SAFETY LIMIT SWITCH; W. W. and G. A. Pierce, Philadelphia, Pa. App. filed Feb. 27, 1909. For preventing jamming of a chain block in an electric hoist by means of a fixed screw and nut, the latter actuating a switching mechanism.

971,322. MINE INSULATOR; C. W. Speakman, Monongahela, Pa. App. filed Nov. 29, 1909. Includes an anchoring element with a stop and an insulator body loosely mounted upon the element and arrested by the stop.

971,352. PARTY LINE INDICATING SYSTEM; C. C. Bradbury, Chicago, Ill. App. filed March 13, 1908. The combination with a cord circuit with a plurality of ringing keys and lamp signals to indicate the key last depressed, the signals serving both as supervisory and party line indicating signals.

971,399. TROLLEY; J. Orszag and John Orszag, Ashtabula, Ohio. App. filed Jan. 12, 1910. A trolley pole and harp with a harp frame pivoted thereon and held horizontally and a trolley wheel in the harp, together with spring-pressed guard arms extending over the wheel and carrying idler wheels to prevent the trolley from leaving the wire.

971,419. ELECTRIC SWITCH; G. B. Thomas, Bridgeport, Conn. App. filed Dec. 17, 1908. Electric switch or spindle carrying a contact and an operating handle insulated therefrom. For incandescent lamps. Details.

971,423. LOCK; F. Walters, Spokane, Wash. App. filed May 6, 1910. Electrically controlled lock with a pivoted latch and pivoted armature connected with the latch, magnet for moving the armature, another magnet for locking the latch and magnets for moving the second armature so as to permit the latch to move.

971,452. METALLIC INCANDESCENT FILAMENT; A. Lederer, Atzgerdorf, Austria-Hungary. App. filed Aug. 25, 1908. A central support with a metallic filament having loop members arranged around the support and anchors for the bent portions of the members, the members being bowed and pressed against the anchors.

971,453. INCANDESCENT ELECTRIC LAMP; A. Lederer, Atzgerdorf, Austria-Hungary. App. filed Aug. 30, 1906. The light-giving portions or filaments arranged in the form of a hollow cylinder, the lines of the filaments being parallel with the axis.

971,485. TROLLEY HARP; L. E. Bradt, Santa Monica, Cal. App. filed Oct. 5, 1909. A replacing wheel on each side of the trolley wheel and having a groove to return the trolley wire.

971,494. TROLLEY CAR POLE ATTACHMENT; G. R. Dunn, San Pedro, Cal. App. filed Oct. 13, 1909. A fork bar carrying the trolley wheel and pivoted to the end of the pole and having a shank and spring chain connecting it to the pole.